BELL TELEPHONE MAGAZINE

VOL. XXI JUNE, 1942 NO. 2

THE RÔLE OF THE TELEPHONE IN THE CIVILIAN DEFENSE ORGANIZATION

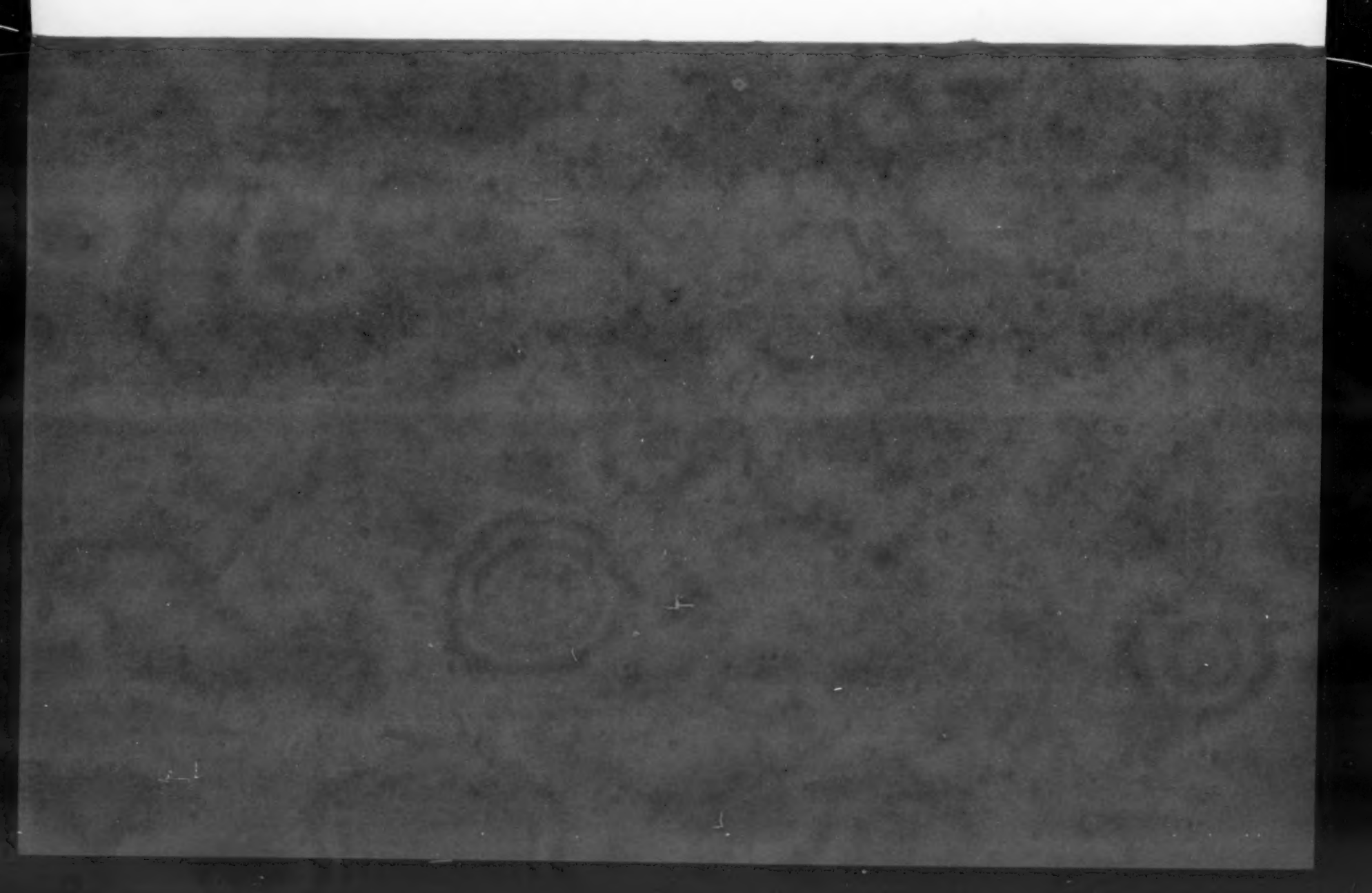
SOME THOUGHTS ON ORGANIZATION AND EXECUTIVE WORK

PLOWING CABLES INTO THE GROUND

THE FUTURE OF TRANSOCEANIC TELEPHONY

"WHAT NUMBER ARE YOU CALLING, PLEASE?"

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK



BELL TELEPHONE MAGAZINE

Continuing the BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

VOL. XXI JUNE, 1942 NO. 2

The Rôle of the Telephone in the Civilian Defense Organization 61
F. Selwyn Gay

Some Thoughts on Organization and Executive Work 80
Walter S. Gifford

Plowing Cables into the Ground 87
Temple C. Smith

The Future of Transoceanic Telephony 109
Oliver E. Buckley

"What Number Are You Calling, Please?" .. 120
Linnéa H. Bauhan and *George L. Goudy*

For the Record 132

The Bell System in War-time: President Gifford's statement at the annual meeting of stockholders—"This Is Your War": a talk by Vice President Arthur W. Page—Service Opened to Dutch Guiana

Contributors to This Issue 135

Published for the Bell System by the Information Department of
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York, N. Y.

BLACKOUT PASSPORT

THE RÔLE OF THE TELEPHONE IN THE CIVILIAN DEFENSE ORGANIZATION

The Bell System Not Only Provides Communication Facilities But Has Trained Representatives Qualified to Act as Communication Advisers to Defense Organizations Throughout the Country

By F. SELWYN GAY

AIR-RAID sirens wail. Municipal and civilian protection groups man their respective posts of duty. Radio stations are silenced. Streets are cleared of traffic. Blackout is effected. The public takes cover. Thus an American city prepares itself for a potential attack from the air. And with incredible speed—perhaps but a matter of a few minutes.

Assume, then, that some enemy aircraft are able to break through our air and ground defenses. Bomb bursts cause damage and casualties. Alert air-raid wardens, on watch, report each incident promptly to defense headquarters. Emergency crews are dispatched to deal with individual incidents. Fires are extinguished, medical attention is rendered, blocked streets are cleared, damaged vital services (power, gas, water, telephone) are repaired. Before the last bomb burst, rescue and repair work is well under way. Lives are saved. Prompt, effective action has minimized the effects of the attack. The city has capitalized on its careful planning and thorough organizing for protection. And each citizen who participated feels amply rewarded for the many hours willingly spent in training and practice.

No, this has not happened here—yet. But it can! If it does, the communities of our country are preparing to carry out the effective protective actions outlined in the two preceding paragraphs.

As part of the task of organizing for civilian defense, both the telephone service and telephone people are doing a vital job—just as they are in other war activities. The importance of the telephone is recognized in an official Office of Civilian Defense publication, "The Control System of the Citizens' Defense Corps," which states: "To properly operate a civilian defense organization, a positive, accurate, and dependable communications system is a vital requirement. Because of its high degree of availability, flexibility, and dependability, the land line telephone is being relied upon as the basic means of communication."

A PORTABLE DEMONSTRATION OF CIVILIAN DEFENSE COMMUNICATIONS

Developed by Bell System companies for the education of their employees, such working exhibits and other presentations have been found useful also for the training of civilian defense groups

The Birth of Civilian Defense and Its "Signal Corps"

THE need of our country for effective civilian defense was recognized during the early days of our defense program. The national Office of Civilian Defense—the O.C.D.—was established early in 1941, followed shortly by nine regional offices coterminous with Army Corps areas. Along our coasts and borders, state, county, and municipal civilian defense councils were formed. Under national and state leadership and with the assistance of the military services, each critical region was carefully studied. War-time protection requirements were crystallized. The work of recruiting, training, and equipping volunteer civilian defense corps got under way.

There has been telephone company participation from the very start, since good communications are essential to civilian defense—as is the case in any emergency work. Telephone people have taken the initiative in offering to assist civilian defense officials with their communications problems.

While the O.C.D. was being organized, for example, such help was offered to and accepted by its director. A liaison officer to represent the Bell System was assigned by the American Telephone and Telegraph Company to work with the O.C.D. staff. A similar appointment was made by the independent telephone companies. This arrangement resulted in a two-way flow of valuable information between the telephone companies and the O.C.D. To the telephone companies went information on the composition of the civilian defense organization

and its various functions which was used to determine both the various specific communications requirements and the most effective and economical communication facilities to meet each need. To the O.C.D., for its consideration, went information on the many services available from the telephone companies, with suggestions as to the usefulness of each from the standpoint of civilian defense.

Out of the coöperative study which accompanied this exchange of information, plans for adequately meeting civilian defense communications requirements were developed. At the same time, the Bell System was determining how it could be most helpful to the civilian defense organization. Its opportunity appeared to be much broader than merely providing facilities and service for civilian defense use: it had, in reality, the responsibility of advising civilian defense officials on communications problems. The job, in effect, was one of acting as the "Signal Corps" of civilian defense.

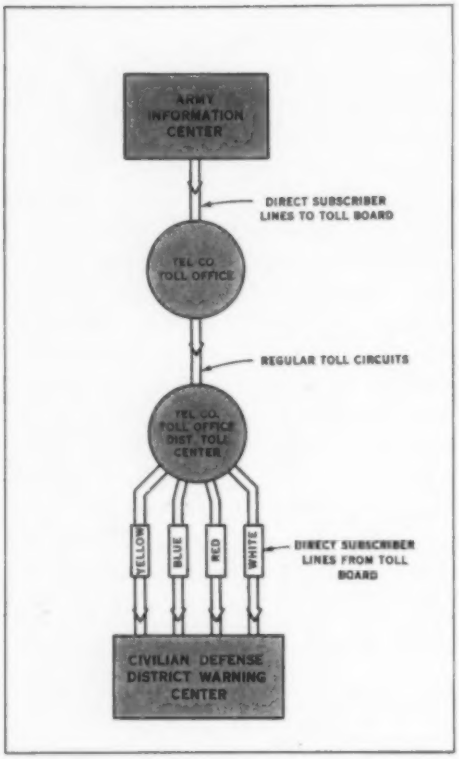
Preparations on the part of the Bell System to handle this new responsibility involved a major organizing and training program, carried out by the A. T. and T. Company. First, there was "recruiting" to do. It was necessary to select and make available in the Associated Companies throughout the country qualified telephone representatives to handle contacts with civilian defense officials. Second, instructive material had to be prepared for use in training these people for this new work. Third, courses of classroom training had to be conducted. This program has already been accomplished and hundreds of representatives throughout the System are now fully qualified to act constructively as communications advisors to civilian defense officials.

Other activities included regional conferences with Associated Company officials regarding the civilian defense program. Sound-pictures, slide films, and traveling demonstrations were created, and were used for the information of telephone employees generally. Such presentations naturally were submitted to civilian defense officials for their approval before being shown. The reaction of these officials to some of the presentations was most favorable and, as a result, the presentations are being used extensively to train civilian defense as well as telephone groups.

The Defense Organization and Its Major Functions

As mentioned previously, civilian defense communications requirements in a given locality depend upon the make-up of the organization and its functions. The extent of activity naturally varies widely between communities, depending upon such things as location, area, population, and other considerations. Furthermore, a given community may move progressively through several stages of preparedness as realization of the danger of attack increases. Communications arrangements, therefore, need to be "tailored" to the specific needs of each community, and modified as changes may necessitate.

The objectives and degree of preparedness appropriate for an individual community are determined by the



AIR-RAID WARNING CHANNELS

This diagram shows how both the Army Information Center and the Civilian Defense District Warning Center are directly connected to long-distance switchboards

local Defense Council, a group which includes authorities on fire and police protection, medical aid, transportation, communications and other such defense matters. Requirements are based on such considerations as the types of incidents the community needs to provide against (bombing, panic, evacuation, etc.), how they may affect the community (cause fires and casualties, interrupt vital services, etc.), and what action such emergencies call for (fire fighting, rescue and repair work, etc.). Such new requirements as develop are met both by strengthening existing agencies (police, fire, utilities, Red Cross, etc.) and reinforcing them with civilian defense volunteers.

The civilian defense organization can be thought of in three broad groups: the headquarters group, termed the Control (or Report) Center; the air raid wardens; and the various emergency services. In event of an air raid, these three groups carry out the following sequence of action:

1. Control Center receives and disseminates air raid warnings, activates the community, and musters defense workers for duty.
2. Wardens patrol and report incidents to the Control Center.
3. Control Center relays incident reports to emergency services.
4. Emergency services dispatch crews to deal with incidents.
5. Control Center exchanges help with other communities as needed.

Throughout this action chain there is a continuous, extensive requirement for communications which becomes apparent in the more detailed discussion which follows. It may seem to deal chiefly with the problem in larger cities. However, size usually affects mainly the size of the organization and the amount of communications, and has little bearing on the nature of the activities to be carried out.

Dissemination of Air Raid Warnings

"TELEPHONE Lines and Air Defense," in the February, 1942, issue of this MAGAZINE, described the system whereby the Army initiates warn-

ings to communities lying in the path of approaching enemy aircraft. Before discussing the dissemination of warnings within a community, it seems appropriate to pick up where that story left off and tell of the arrangements for getting air raid warnings from the Army Information Centers, where they originate, out to individual communities.

The warnings are transmitted by message telephone service. Owing to the speed of aircraft and the uncertainty of their course, it is necessary to warn rather substantial areas. Consequently, Warning Districts, each having a Warning Center, are established in each state where air raid protection is necessary. The size of these districts varies but is illustrated by Massachusetts, where nine districts have been established.

There are at present four degrees of warning:

YELLOW—Air raid is possible.
BLUE—Air raid is probable. Enemy planes approaching.
RED—Air raid is imminent. Attack may occur in short time, say, 5 minutes. Sound public alarm.
WHITE—All clear.

A blackout can be ordered for a region regardless of the degree of warning in effect. This is likewise true of silencing radio broadcasts.

It should be pointed out that these warnings are the subject of continuing study and tests, and may therefore be changed from time to time as experience and circumstances warrant.

The Army arranges to have each Warning Center provided with a special telephone which has four keys. Each key is associated with a line to the long-distance central office, and with a lamp signal. There is a combination of line-and-key-and-lamp for each of the four degrees of warning; the key and lamp are of the same color as the warning they represent.

For example, when the Army sends a YELLOW warning to a Warning Center, a bell rings and the yellow lamp lights. The Warning Center attendant depresses the yellow key and, using the telephone hand set, acknowledges the warning with "Bridgeport

WARNING-RECEIVING EQUIPMENT

The keys in the base of the telephone, and the lamp caps of the visual signal, are colored yellow, blue, red, and white. Each is connected to a separate line operated on order from the Army Information Center

IN A DISTRICT WARNING CENTER

The key equipments, which speed up the warning calls by giving access to several lines, may be seen at the left of this picture

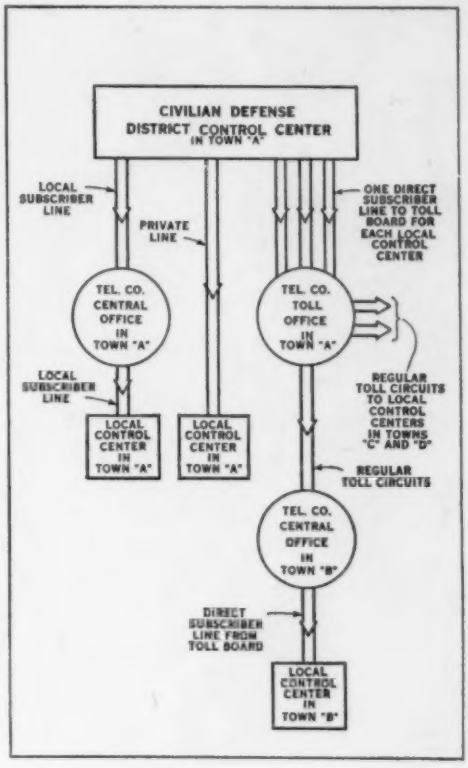
Warning District, YELLOW." On pages 64 and 65 are a schematic diagram of the air-raid-warning telephone communications channels between an Army Information Center and Warning Center and a picture of the warning receiving telephone equipment here described. Giving Army Information Centers and Warning Centers direct connection with long distance, rather than through local central offices, is a means of speeding up the service and further reduces the possibility of error.

At this point Army responsibility ends and civilians take up the job of disseminating the warnings within the Warning District. Generally the warnings disseminate from the Warning Center by message telephone service to the Control Centers of individual communities. However, there may be variations to this method of routing warnings; e.g., warnings are sometimes relayed through a District Control Center which has been established to coördinate the activities of several neighboring communities. Also, police and other teletypewriter networks are sometimes used for warning dissemination. Above is a picture of a District Warning Center, showing the key equipment used to expedite messages, and at the right is a schematic diagram of the warning

telephone communications channels between Warning Centers or District Control Centers and local Control Centers. All of the above arrangements were worked out jointly by Army and Civilian Defense officials and telephone representatives.

THIS background brings us to the last link of the warning chain, which is forged largely by the individual community. Based on a study of the steps required to prepare for an attack and the time involved, lists are developed of individuals and groups to receive the YELLOW and BLUE warnings. Such lists include three groups: (1) Key people in the civilian defense organization, e.g., personnel required to operate the Control Center, and heads of such essential services as Fire, Police, Medical, Repair, Utilities, etc.; (2) Schools, hospitals, and other such institutions where special steps have to be taken to protect large groups of people located on the premises; and (3) Large war plants in those cases where the steps necessary to prepare for a raid require an appreciable amount of time. The exact composition of warning lists must, of course, be determined individually by each community, based on a careful review of its requirements.

Only a limited number of these advance warnings can be transmitted over regular message telephone service. Excessive use of the telephone at such critical times would congest the telephone system, and thus some calls most important to civilian defense might not get through. To avoid congestion of the telephone system, civilian defense officials and telephone people in each community


CIVILIAN DEFENSE DISTRICT CONTROL CENTER IN TOWN "A"
LOCAL SUBSCRIBER LINE
PRIVATE LINE
ONE DIRECT SUBSCRIBER LINE TO TOLL BOARD FOR EACH LOCAL CONTROL CENTER
TEL. CO. CENTRAL OFFICE IN TOWN "A"
TEL. CO. TOLL OFFICE IN TOWN "A"
LOCAL SUBSCRIBER LINE
REGULAR TOLL CIRCUITS TO LOCAL CONTROL CENTERS IN TOWNS "C" AND "D"
LOCAL CONTROL CENTER IN TOWN "A"
LOCAL CONTROL CENTER IN TOWN "A"
REGULAR TOLL CIRCUITS
TEL. CO. CENTRAL OFFICE IN TOWN "B"
DIRECT SUBSCRIBER LINE FROM TOLL BOARD
LOCAL CONTROL CENTER IN TOWN "B"

DISTRIBUTION OF THE WARNINGS

In this diagram, channels from a District Control Center to the Control Centers of several neighboring communities are represented

jointly develop the warning lists, giving due consideration to the capacity of the telephone facilities for handling warning calls. Particularly dangerous at such a time are the so-called "chain calls" of excessive length, whereby a small group is called from the Control Center and they in turn call a larger group, and so on. To show how such calls "snowball," if an attempt were made to reach about 1,000 people in 10 minutes, there would be a wave of over 500 calls during the last minute and over 120 operators would be required in a

REPORTING AN INCIDENT
Wardens are the sentinels of civilian defense

manual central office to complete them within the deadline.

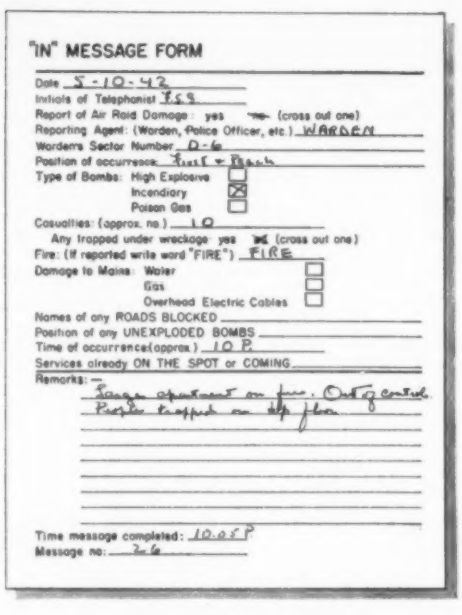
Mustering the Organization for Duty

EVEN though an efficient air-raid warning system has been organized, experience on the Pacific Coast, where actual warnings have been issued, indicates that the amount of advance warning of potential attacks will vary considerably, particularly in the coastal and border areas. While in some cases an emergency may be heralded by a YELLOW warning from the Information Center well in advance of any possible attack, in other cases the first indication of danger may be a RED warning.

In view of this, the following steps are being taken by defense officials of many communities to insure that the defense organization is available for duty as needed:

First, organizations are being built up of volunteers who are continuously available to assume civilian defense responsibilities. An example of good availability is a person who lives and works in a community, while the opposite is true of a commuter who is out of town most of the time.

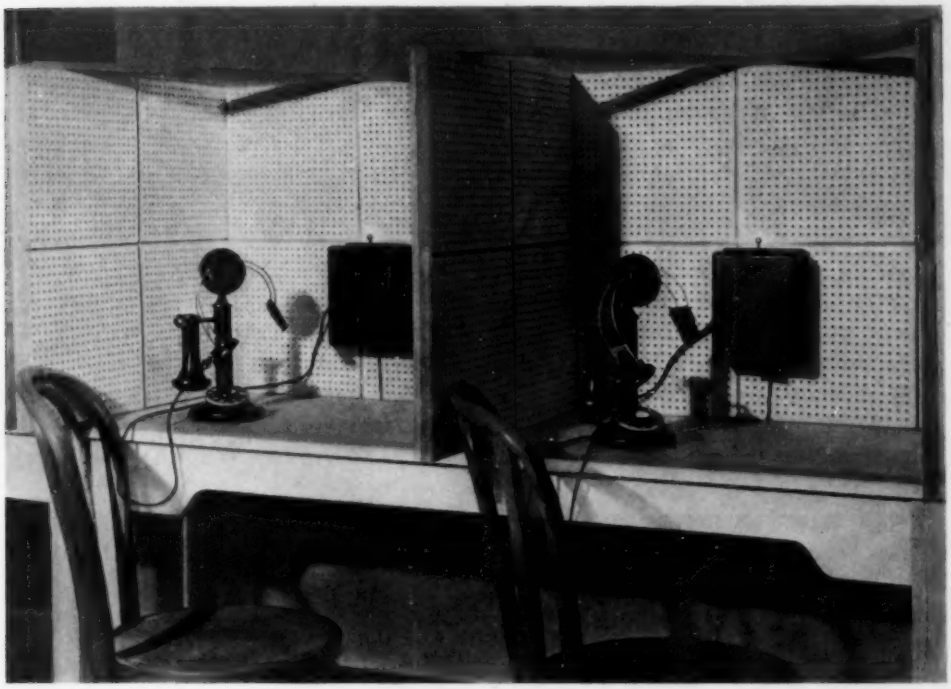
Second, in so far as is practicable, civilian defense assignments are made so that the post of duty of each volunteer is in the immediate vicinity of his home or place of business. Wardens,



"IN" MESSAGE FORM

Date 5-10-42
Initials of Telephonist T.S.
Report of Air Raid Damage: yes ~~no~~ (cross out one)
Reporting Agent: (Warden, Police Officer, etc.) WARDEN
Wardens Sector Number D-6
Position of occurrence First & Beach
Type of Bombs: High Explosive ☐
Incendiary ☒
Poison Gas ☐
Casualties: (approx. no.) 10
Any trapped under wreckage yes ~~no~~ (cross out one)
Fire: (If reported write word "FIRE") FIRE
Damage to Mains: Water ☐
Gas ☐
Overhead Electric Cables ☐
Names of any ROADS BLOCKED
Position of any UNEXPLODED BOMBS
Time of occurrence(approx.) 10 P.
Services already ON THE SPOT or COMING
Remarks: —
Range apartment on fire. Out of control.
People trapped on 4th floor.
Time message completed: 10.05 P
Message no: 2-6

THE REPORT
This is the information about an incident as received and recorded at a local Control Center



TELEPHONISTS' POSITIONS

This is where wardens' "incident reports" are received. By removing the bells from the bell boxes, the clappers become visual signals, while use of the head receivers leaves both hands free

for example, are assigned for duty on blocks on which they live or work.

Third, schedules are being established so that each volunteer knows the specific hours and days when he is committed to be "on call," and someone is "on call" to cover all important posts "round the clock." For example, a volunteer fireman who is scheduled to be "on call" Mondays, Wednesdays, and Fridays between midnight and 8:00 A.M. would arrange his affairs so that he would always be available for duty during those periods if needed. This arrangement, of course, causes some readjustments on the part of volunteers, just as is the case when a woman agrees to work at Red Cross headquarters every Thursday from 8:00 A.M. to 6:00 P.M.

Fourth, the work of volunteers is being organized so that a minimum of time is required in making preparations for an attack. Control Centers, medical stations, etc., are being efficiently organized and equipped so that workers can go into action as soon as they reach their stations.

Fifth, certain important points, particularly in the critical areas, are manned by skeleton forces twenty-four hours a day. For example, this is the case in connection with Warning

District Centers and Control Centers in most communities in the North Atlantic and Pacific Coast States.

Once these measures have been effected, the sound of the siren musters the majority of defense workers and there is no need for long YELLOW and BLUE warning lists. This is in the best interests of our nation, which require that normal civil pursuits and business be carried on without interruption due to air-raid hazards, until the last possible minute consistent with public safety. Otherwise, widespread knowledge of advance warnings, particularly those which are not actually followed by a RED warning, would inevitably cause wasteful interruption of war production and affect public morale adversely.

Patrolling and Reporting Incidents

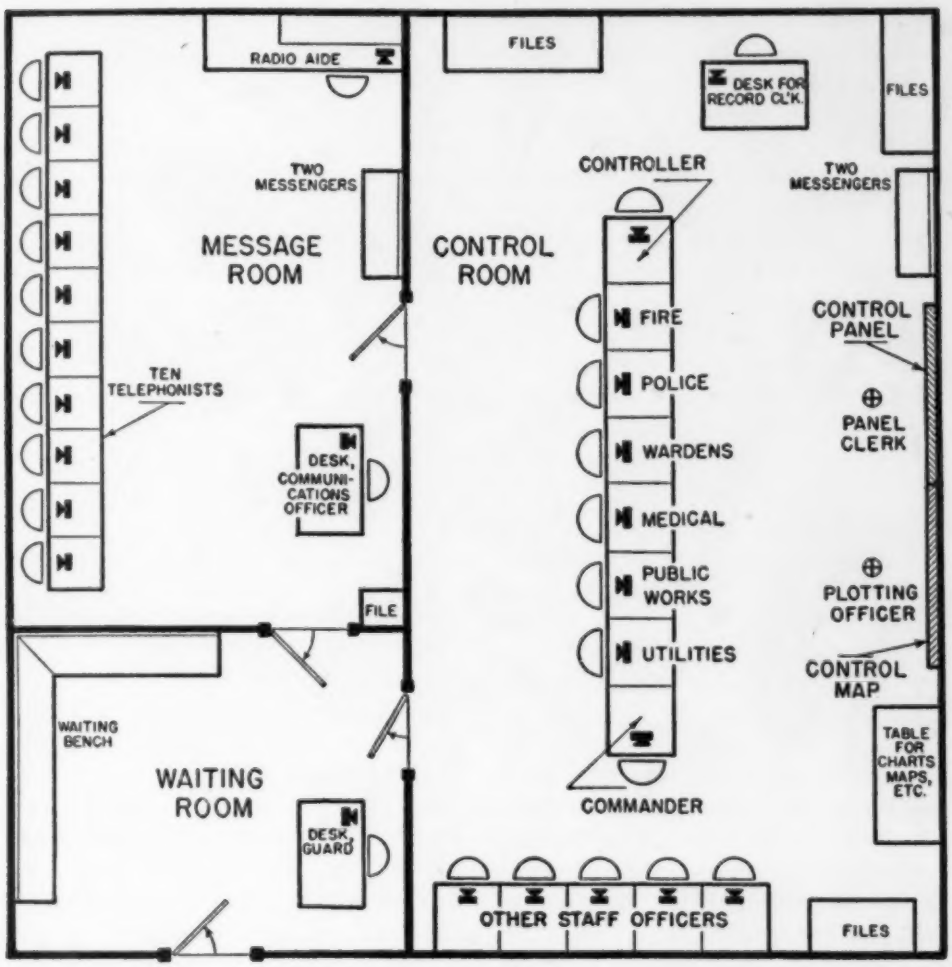
WARDENS are the sentinels of civilian defense. Their functions are similar to those of police patrolmen or guards and watchmen in private business. They are mustered when such patrolling agencies require reinforcement. They start patrolling their posts when the RED (or public siren) warning is given, and (1) warn the inhabitants of impending danger, (2) prepare their area for an attack, e.g., effect blackout, clear streets of traffic, and help the public to take cover, (3) spot and report damage and casualties to the Control Center, and (4) render such other assistance as they can.

The areas covered by warden posts vary in size, depending upon such factors as topography and density of population. In urban areas it is a common practice to organize warden posts on the basis of one for each block or several square blocks. From those who live or work on the block, enough wardens are recruited to insure short-notice, 'round-the-clock, daily coverage. For the purpose of supervision, warden posts are grouped into sectors, precincts, and so on.

The wardens require communications primarily for reporting incidents to the Control Center. This need is being met by selecting existing telephones strategically located along each warden beat. Coin telephones as well as residence and business telephones can be put to this use. Arrangements must be made, of course, so that wardens have access to them at all times —day, night, Sundays and holidays.

By using existing telephones, a community saves considerable money and contributes to the conservation of telephone facilities which is so important under present war conditions. For example, in one city of about 500,000 population, wardens use about 3,000 telephones for reporting incidents. If the city had been unable to use existing telephones, a substantial amount of critical materials would have been required which can now be devoted to other war purposes. Also, the number of telephones required by wardens can be held to a minimum if such telephones are selected close to street intersections, since at such locations one telephone may serve as many as four warden posts. By putting this rule into effect, one community was able to reduce the number of telephones designated for warden use by over 30 per cent.

To reach the Control Center, wardens ask for or dial the telephone number assigned to the Control Center incoming lines. When the Control



LAYOUT OF A CONTROL CENTER

This typical arrangement is reproduced from "The Control System of the Citizens' Defense Corps," issued by the O.C.D. The symbols represent telephones

Center answers, they give a terse but adequate report covering the incident.

The Control Center

THE Control Center is the nerve center of civilian defense. It is usually established in a centrally located public building which affords adequate space and good protection. Larger cities may require several Control Centers which are coördinated by a main Control Center.

The Control Center force is composed of two groups. The first is a group primarily responsible for recording the incoming warden incident reports. They are stationed in a message room. The second is the staff organization, which analyzes each incident and notifies the various emer-

gency services in cases where their help is needed. They are located in a staff room. The Control Center forces are all summoned for duty as promptly as possible following the recept of a YELLOW warning. However, as mentioned previously, many Control Centers, particularly in the zones of possible military operations, are manned by skeleton forces continuously.

The facilities used for receiving warden incident reports are another example of efficient planning. In a typical Control Center, the telephone set and signal provided at the incoming telephone positions in the message room were selected so as to meet adequately the needs without requiring special elaborate equipment. Desk stand telephones with head sets, giving the telephonists free use of both hands, are used. The signal of an incoming call is obtained from a regular bell box, minus the cover and bells, which is mounted before the telephonist. When there is a call on the line the clapper, which has been painted a bright color, vibrates to announce the call. By converting the bell box from an "audible" to a "visual" signal, room noise from a lot of telephone bells, closely spaced, ringing simultaneously, is eliminated. On page 69 is a close-up of telephonist positions.

The lines from the central office to these telephone positions are consecutively numbered. The Control Center number, mentioned earlier, which wardens call is actually a single telephone number covering this whole group of lines. By this arrangement the operators or machines in the central office seek out and complete calls to idle lines, obviating the need for a P.B.X. switchboard and attendants in the Control Center to distribute these calls.

The number of positions and incoming lines depends upon the volume and density of incidents anticipated. One Pacific Coast city felt it should provide enough lines to accommodate a flow of about 400 incident reports per hour. Tests showed that 40 lines would give such input capacity. A mid-west city of comparable size, on the other hand, might provide for a much smaller volume, in view of the better protection its location provides from attacks by air.

Dispatching Emergency Units

THE Control Center staff is in charge of a chief and has the following members: a medical officer, chief air raid warden, representatives of the fire and police departments, the community's engineer or director of public works, and representatives of the water, gas, power, communications and transportation companies. In small cities, many of these jobs may be combined. As mentioned previously, the staff is assembled on receipt of the initial warning. Its function is to analyze incident reports and notify the emergency services involved.

As each member of the staff arrives at the staff room, he places a call to the dispatching point of the service he represents, using the telephone at his position. When it answers, he orders "Stand by for action." A private line connection for continuous, exclusive use between a staff man and his dispatching point may sometimes be required. More often, however, regular individual message telephone lines at

THE CONTROL ROOM OF A CONTROL CENTER

This is the main message center of the community. It is here that the orders are swiftly issued to meet the situations which are revealed by the wardens' reports

staff positions prove adequate, since a connection with the dispatching point, once it has been established via the central office, can be maintained continuously if required throughout the period of emergency.

Soon after the staff men reach their posts and establish contact with their dispatching points, incident reports start coming into the message room. Immediately after a telephonist completes recording an incident, she sends the report by messenger to the staff room. The chief reads the report aloud. Each member of the staff passes by telephone to his service dispatching point such details as affect it.

Tests may show that variations of the plan just outlined are desirable. For example, rather than passing messages directly to their dispatching bureaus, the representatives of the services might prepare "out" orders and have telephonists give these orders by telephone to the several services.

To hold down duplicate reports, each incident can be spotted on a map with a numbered pin before the report is given to the chief. If, when placing pin 23 at the location of incident number 23, it is found that pin 20 is at the same location, the report would be stamped, "Probable Duplicate." The

chief and his service representatives can then treat it as such.

From a communications standpoint, the Control Center is the main message center of the community. Communications must be engineered so that incident reports can be translated into action at top speed. There must be no bottlenecks along the road to the Control Center, within it, or between it and the various emergency services. The whole system should be pointed toward getting appropriate help to the scene of an incident as soon as possible after it occurs.

Even more may be required, however. The Control Center must be ready to deal with severe and protracted attacks, resulting in hundreds of incidents: more than its people and equipment are able to cope with. It must be prepared, therefore, both to exercise selectivity in notifying the emergency agencies of incidents and to obtain help from other Control Centers when help is needed.

Here are examples of delays along the road into the Control Center which may involve communication arrangements. (1) Too much time spent by warden traveling to telephone to make report. Cause: Poorly located or too few telephones selected for wardens' use. (2) Incident reports blocked due to "busies." Cause: Too few lines to the message room. (3) Incident reports delayed due to "slow answers." Cause: Too few telephonists on duty, or inefficiency. Delays may likewise be caused, of course, by improper arrangements in other parts of the Control Center.

It is very important that checks be made within the Control Center to determine whether the staff is able to clear incident reports with the various emergency services as fast as the full complement of telephonists can accept them from the wardens. If this is not the case, incident reports pile up in the Control Center much as war freight would pile up at the dock terminal of a railroad if there were a shortage of cargo vessels.

The speed of the staff in clearing incidents can be determined during practice tests. Such a test, for example, might show that one unit of staff can clear incidents as fast as 10 telephonists can take them in. Then, if the Control Center requires 20 telephonists, it follows that two units of staff or a breakdown into two Control Centers are needed. Under these circumstances, of course, at the dispatching point of each of the services two people and two telephones for receiving reports from the Control Center would be required.

These figures are only illustrative, of course. Actual figures can be obtained only through tests conducted by the individual Control Centers.

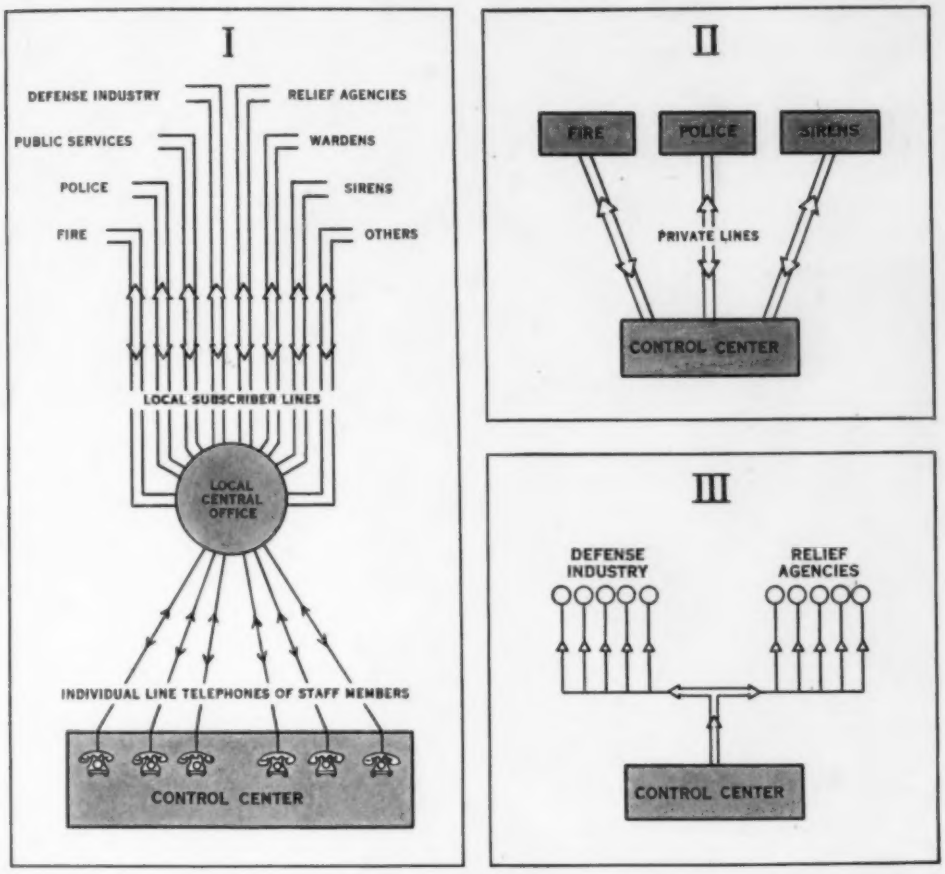
Telephone people are able to be helpful in organizing tests of this type, because of the years of experience in the telephone business of measuring telephone work loads and dealing with force adjustment problems.

Dealing with Incidents

THIS is the job of the third major division of the civilian defense organization, the Emergency Services, including such groups as the following:

(1) *Emergency Medical Units*

These groups are usually organized by the local hospitals, the Red Cross, and the municipal public



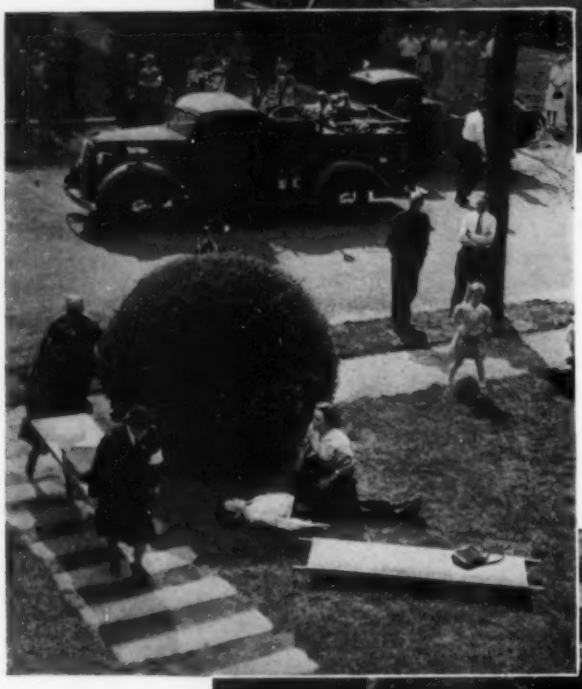
POSSIBLE COMMUNICATIONS ARRANGEMENTS

These diagrams represent the use of different methods by which the Control Center may communicate with its organization. I shows the use of regular message telephone service. II indicates private lines to certain important agencies. III represents a grouping of private lines over which messages may be sent to as many as 10 agencies simultaneously. Which arrangement best suits the needs of a community depends on many factors

health departments. Casualty stations, manned by doctors, nurses, and first-aid volunteer workers, may be established at strategic locations, such as churches, schools, and libraries. Casualties would be taken from the scene of the incident to these stations for examination and treatment and then sent home or to a hospital.

The existing telephone service arrangements at the location may usually meet the requirements of the station staff, their contacts being mostly with the scene of incidents, hospitals, the Control Center, and other casualty stations.

With regard to a hospital's regular telephone service, steps should be taken to insure that its service arrangements will be effective during emergencies or surges in telephone calls. Where nurses' homes and other



Above: An emergency medical unit leaves for the location of a reported incident

Left: Medical and other agencies converge on the scene

Below: A casualty is removed for more extended treatment, after having received first aid

It Can Happen Here

Scenes from a realistic test of Civilian Defense agencies carried out in a New England community

buildings are to be used for auxiliary hospital accommodations, existing telephone facilities can be reviewed to see if they meet emergency requirements. The changes required, if any, are usually minor.

(2) *Fire Fighting*

A volunteer auxiliary may reinforce the regular fire department in activities to reduce fire dangers, as well as in fighting fires. In some communities their auxiliary volunteer fire stations are established at strategic locations, such as large service stations or public garages. In very large buildings and industrial plants, there may be volunteer fire-fighting groups.

For contacts with the fire department, the Control Center and other auxiliary fire stations, the auxiliary stations can use the existing telephones at the location. Several other conveniently located telephones can be spotted which could be used if regular telephones should be interrupted.

(3) *Repair crews*

Services such as power, gas, water, telephone and transportation companies have, of course, their own repair forces, which are generally sufficiently large and flexible to restore interruptions speedily during emergencies. For repairs to streets and public property, municipal agencies likewise have repair organizations and contractors or others who can help. Unless there is a disaster, such as a severe bombing, volunteers are not likely to be called upon to do repair work on an organized basis. The telephone arrangements of utilities and vital public services usually have been planned so as to provide for possible contingencies.

(4) *Police and Traffic Groups*

Volunteers may assist the regular police department in a number of ways. Some may take over certain police clerical and other routine duties, thus releasing policemen for more active assignments. Some may reinforce the regular police patrol when necessary. Others may guard bridge heads, aqueducts, and other vital points. Traffic duties also may be assigned to volunteers, such as guiding repair and rescue crews to the scene of an incident, forming a cordon around the incident, rerouting traffic around streets which are blocked, and the like. When on duty, they can use existing service such as police telephones, wardens' telephones, public telephones, and telephones in casualty stations.

FROM the Control Center, over the telephone facilities described above, goes information covering incidents which enables the emergency services to make the most effective use of their organizations and equipment during the period of emergency. It permits them to go only to those incidents where their help is really needed. It also gives them a good picture of the type and amount of work they will have to do. For orders and other communications between their main dispatching points and various emergency units of the several emergency services, adequate telephone arrangements are usually available for dispatching purposes. However, telephone people are taking the initiative in reviewing this situation with the services, and are suggesting changes if they appear to be needed.

When the several emergency services reach the scene of an incident,

the senior official present may become the Incident Officer and coördinate activities, or the Control Center Chief may send an Incident Officer to the scene from the Control Center. He establishes a field headquarters and message center serving all the defense units, usually at the nearest telephone which can be used for communication with the Control Center. The nearest warden telephone or public telephone would preferably be selected. To insure that a telephone will be available for use in case of damage to a large defense industry, hospital, public utility, or other important unit, the authorities can get three or four subscribers in the immediate vicinity to agree that their telephones can be so used in case of an incident. Such telephones should be selected, if possible, so that they do not all work off the same cable.

Some communities plan to use a loud-speaker on a truck at the scene of the incident to call the supervisors of defense units and others to the telephone. "Runners" can also be used to carry written messages between the scene of the incident and the Incident Officer's telephone.

EACH community strives to build for itself such protection as it may need. The possibility is generally recognized, however, that a catastrophe may be so severe as to require outside assistance. To facilitate the exchange of such assistance, communities are grouped together into Control Districts. Each such district has a District Control Center through which the Control Centers of individual communities work in exchanging help.

District Control Centers are normally established in the largest community in their respective areas. Suitable space can usually be found in a municipal government or other public building.

A District Control Center organization would normally consist of a Controller, Assistant Controller, Plotting Officer, Communication Officer, and several telephonists and messengers.

Several telephones are usually necessary at a District Control Center for contact with its local Control Centers. Each telephonist and each Controller usually has one telephone. If specially installed, they can be consecutively numbered, non-published lines. Local Control Centers requiring outside help would call these lines. After recording a request, the telephonist would pass it to the Controller for action.

Many municipal or utility services have procedures for exchanging help with neighboring communities even in normal times, and these may require some modification to facilitate coördination with the District Control Centers.

Important Guides in Communications Planning

THE broad objective in any communications planning is to secure fully effective service arrangements at the most reasonable cost possible. This is the "Golden Rule" of telephone people whose job it is to act as communications consultants for civilian defense officials and all others who need help with communications problems. The application of this rule to the requirements of civilian defense clearly

shows that the following important guides should be observed in communications planning:

(*a*) To use regular message telephone service wherever practicable.
Due to its speed and flexibility, it adequately meets most civilian defense requirements and it will usually be the most economical form of service. Because of increasing demands upon the communications system, it is in the national interest not to take long-distance lines out of general use by using them as intercity private telephone lines, unless unavoidable to insure effective functioning in connection with the war effort. The same considerations apply, although to a lesser degree in some areas, to local private line service.

(*b*) To use standard telephone equipment as far as possible.
Specially designed telephone equipment is rarely needed. Standard equipment is generally less expensive, simple, easy to operate, and readily available with no waiting for special development work or manufacture.

(*c*) To use existing telephone facilities wherever practicable.
Additional telephone facilities should be installed only when it is certain that existing equipment will not meet requirements. For example, wardens use existing telephones on their beats instead of installing special facilities for them.

(*d*) To plan for "all out" defense requirements, and to order service adequate to it, but only to the extent that the community is actually organized for it. In the meantime, interim telephone arrangements can be provided which will be satisfactory for practice or emergency use.

Above all else, any use of the telephone planned for civilian defense should be carefully coördinated with the usage of military services and war industry to insure the most effective use of facilities.

SOME THOUGHTS ON ORGANIZATION AND EXECUTIVE WORK

These Are the Tools for the Accomplishment of a Desired Result; In This Day of Statesmanship in Business, Those Who Use Them Must Be Leaders and Administrators as Well

By WALTER S. GIFFORD

When the Bell Telephone Quarterly *was established in 1922 as "a medium of suggestion and a record of progress," the editors sought contributions from officials of the Bell System headquarters company which would state or explain the ideals, aims, and principles of Bell System management.*

The second issue, published in July, 1922, contained some notes on organization by Mr. W. S. Gifford, then financial Vice-President of the American Telephone and Telegraph Company. Mr. Gifford's views, thus expressed twenty years ago, are reprinted here since they are particularly interesting when read in relation to the System's growth under his leadership in the last two decades and its responsibility to-day in connection with the nation's communications needs.

The Editors

What is organization? And why is organization? What are the functions of an executive?

We hear a great deal about organization in the business world. We hear that this man is a great organizer, or that man is a capable executive. We still hear at times of "Captains of Industry." We occasionally hear of a good administrator, although the terms "administrator," "administration," and "administrative" are largely confined to governmental affairs. In business we hear more and more of "committees" and "conferences." All of these words and phrases are descriptive of certain types of machinery by which modern business is carried on.

In the hope that others might be stimulated to think about the subject, I have set down some notes as to the significance of these terms. They are simply suggestions based to some extent on personal experience and conviction, and even more upon observation of successful executives in their work.

In the first place, we are not in the business of being organizers as such, or executives for the sake of being executives—though indeed one might believe the reverse of this to be true, judging by the requests for employment which we frequently receive from men who "want a job as an organizer or an executive." These men might almost as well say they would

like a job somewhere as a captain, and feel perfectly well qualified to fill the job whether it be a captain in the army or captain of an ocean liner.

Organization and all the machinery associated with it are not ends in themselves, but tools for the accomplishment of some desired result. This seems too obvious to need to be stated; but it is easy to forget the obvious unless we are constantly on guard. We must constantly study our organization to see if it is best fitted to give results. Moreover, we must not overlook the fact that while it is a tool, and in most cases an indispensable tool, it is not the only tool needed for accomplishment.

Organization is a rather simple tool to construct. The difficulty lies in first analyzing clearly the job to be done. For example, here are five men who want to unite to build a coöperative apartment house. Each of the five must not start off independently to buy lumber or engage an architect or dig the foundations. They must first lay out and plan what they want and then determine what needs to be done to secure what they want. After this has been done, the problem becomes one of setting up the organization. This involves a decision as to what part each can do best, and an agreement that some one of the five shall be in charge of coördinating the work.

Organization a Means to an End

ORGANIZATION means order. We may of course become so fascinated with organization in itself and for itself, with the game of organizing, that we overdo it. We may, for instance, become so enamored of organization charts that because a particular setup, which we know works well and is useful, cannot be charted, we change the organization.

There are real temptations to the lover of order and system. His protection lies in constantly keeping in mind the end to be attained and making all of his plans with that end in view. To be a good organizer requires sound judgment, ability clearly to perceive the goal sought, an analytical mind, and a certain fondness for order. A real organizer is always creative: it requires a man with a creative imagination clearly to perceive the goal sought.

Many of us are asked from time to time for a good book on organization. It is true that much could be written on the fundamental principles of organization, but no book could be written which would properly instruct exactly how any particular work or business should be organized. Study and books may help define the problem somewhat and perhaps lay down some fundamental principles which will assist in solving it, but no textbook where you would find your problem stated and the answer given in the back of the book would be a safe guide.

There is nothing mathematical about organization in business. It is true, for instance, that probably no chief executive should have more than five or seven people reporting to him. This, however, is due to the average limitations on the part of the average man to direct and coördinate comfortably a number of functions. The exceptional man might find it quite

possible to carry on his work as a chief executive with as many as twelve people reporting to him, or another man who might also be successful as an executive might prefer only three. In other words, you can never escape from the human side of the business and the fact that you are dealing not with machines but with human beings. So that even after you have organized your job and laid out the theoretical organization which can best accomplish it, you will almost always find it necessary to make variations from this theoretically sound organization to meet the peculiarities and temperaments of the individuals who are to carry on the work. It is always a good plan to have the ideal in mind and to work toward it; but by all means do not try to crowd human beings into a theoretical scheme when they do not fit.

Duties of an Executive

THE executive may be merely an executive; that is, he may carry out plans and programs which have been laid down for him. That is in fact the primary job of an executive. He must deal with men and women; therefore he must have sympathy, tact, and force, and must know when to be firm and when to be conciliatory. His must not be a single-track mind—he must be alert and able to see many things at the same time, but must not permit himself to be overwhelmed by details. He must always watch for actual results—must know the difference between real accomplishment and making a show of accomplishment. Above all must he be just and fair in his treatment of his subordinates, and should always be a leader.

An executive generally must be even more than this. He must be also an administrator. That is, he is not only expected to carry out plans laid down for him, but he is expected in part to make plans and carry them out on his own initiative and to assist in determining broad policies for the business as a whole. He must therefore have initiative, imagination, and judgment. These qualities are inherent; they cannot be acquired. They can, however, be improved by training and experience.

There are several ways of performing the functions of an executive. Sometimes a man's personality will enable him to be a good executive even though he disregard many of the generally accepted methods of supervising a large organization. Generally speaking, however, a good executive should not be too busy. This is particularly true if in addition to being an executive he is to do some general administrative work. The mistake should not be made, however, of assuming that because an executive's desk is always clear, he is a good executive. It is an admirable thing to have a clear desk, but with it must go certain principles of work which will keep the executive in touch with his department and enable him to impress his personality upon it.

More Than a Clearing-house

I REMEMBER once hearing of a boy who asked a man what sort of work he did in a company. The man was a high executive. His reply stated his job too modestly, but it illustrates the point. He replied that people came in to see him, stated what they wanted to know, and then he referred them to

the proper department of the organization. The boy said he understood perfectly, because in his father's business they had an usher—he sat at the desk out in the hall—who did just that. An executive who does just that may really be somewhat more than an usher, but not much. He does not impress his personality upon his work. He is merely a sort of clearing-house.

It is necessary, of course, for an executive to see that work is properly distributed and coördinated in his organization, but it is also necessary for him to keep in constant touch with his men and with the work which is being done under him. He should always be available to his immediate subordinates. In my opinion, this is more important than that he should be accessible to people outside of his organization. He should discuss their problems with his subordinates and give them the benefit of his advice, and avail himself of every means of keeping in touch with them and keeping them in touch with him.

BESIDES this, an executive should have some line of contact with the men in his organization below the rank of those who report immediately to him. He should call for information from anyone in his organization from time to time—although, of course, he should never issue instructions or orders except through his immediate subordinates. By thus calling for information from anyone he is able to get a first-hand knowledge of the men working in the business and of their mental attitude toward their work. This seems to me a very important point, although its soundness from an organization standpoint is frequently questioned. People who are in love with organization as such feel that everything should "follow the lines of organization," with the result that a single fact wanted will often have to be requested through eight or ten people and after the fact is ascertained will have to be reported back through the same eight or ten people. Such a procedure reminds one of the old nursery rhyme, "Stick won't beat dog, dog won't bite cat," etc.

Getting the Work Done

IT cannot be too frequently stated that really to be effective an executive must always keep his mind on what it is that he is trying to accomplish. Of course this will never be anything but what is for the good of the business. So it be consistent with the good of the business, ambition is a good thing, but the desire for self-aggrandizement and the desire for power not as a means to an end but as an end in itself, are most serious human failings to be dealt with in running an organization. From the standpoint of getting the work done, it often makes no material difference whether a particular line of work is in one branch of the organization or in another. The organization as a whole will never function without coöperation between the branches, and with coöperation, the placing of work in one department rather than another is often of no material consequence. A desire, however, on the part of one executive to build larger at the expense of some other executive is very often a cause of friction and difficulty. With the

successful executive the problem is not one of finding additional work to add to his organization, but of preventing jobs which do not belong to his organization being assigned to it. The executive who works hard to add to the size of his department condemns himself as a good executive.

Another difficulty in the practical operation of a large organization is frequently due to a lack of clear definition of responsibility and authority. Every executive is entitled to know clearly where his responsibilities begin and end, and he is entitled to have definitely the authority which will enable him to meet his responsibilities. Not only is every executive entitled to this, but when he in turn divides up his responsibilities and authorities among his immediate subordinates he must be especially careful to see that those authorities and responsibilities are clearly defined and understood. He cannot under any condition blame a subordinate for something for which the subordinate has no authority because without authority he cannot properly be held responsible.

A good executive realizes that there are a good many ways, and probably several very effective ways, of accomplishing a given result. He will have no foolish pride of opinion, no troublesome prepossessions. He will welcome intelligent opposition and suggestion from anyone and be quick to surrender a prejudice. While he will impress his personality on his organization, he will not insist that everything be done his way, as this will kill initiative and enthusiasm and make his organization a mere machine.

A Good Judge of Men

FINALLY, a good executive must be a first-rate judge of men. Perhaps his most important task is the selecting of his department heads. If he does this wisely and successfully, a good part of his task is done. Having selected them, he must trust, inspire, and lead them. He must command and retain their confidence and must be frank with them and fair to them. A successful general is one under whose leadership a staff and rank and file will work and die with enthusiasm.

While authority and responsibility must be clearly defined for executive work, there is, as I have already pointed out, another type of work which I have called administrative. It is not altogether possible to define the authority and responsibility for administrative work. The responsibility for such work is to some extent joint with all the higher executives of an organization. The final decision undoubtedly rests with the head of the organization, but he will wish to take counsel frequently with those who are not primarily responsible for the matter under discussion.

This counsel the chief executive may obtain by discussions with one individual at a time, possibly asking the opinion only of those whose judgment concerning the matter in question is especially valued. Some executives from temperament or even preference have been known to follow this plan only.

It is my personal belief that by far the best results are obtained by conference. To some minds conferences are a waste of time. Much is said that does not appear to bear upon the

point under discussion. There is often a good deal of talk, but when important matters of policy are to be decided, I feel sure that the time used or even used up in conferences is very much worth while. When the chaff has been winnowed out, the wheat will be found.

It is important in a conference that everyone be given an opportunity to talk at length, that ideas expressed be listened to with tolerance by all. A prominent man once said that people's personalities and peculiarities meant no more to him than the weather. While this is going too far, nevertheless a conference held with a view to determining policies is not a place where tact and finesse are so necessary as freedom of speech. I realize that in business, one-man authority and responsibility, with the speed of action which results therefrom, is thought by many to be a great deal more effective than the slower process of conferences. I feel sure, however, that in an organization where large matters are at stake and where military authority and discipline are not required, the only safe and efficient way to determine policies is to confer deliberately and at length. Of course, the head of the organization must finally decide, and after deciding, act with firmness and confidence.

The Uses of Committees

ANOTHER type of machinery, excellent for the accomplishment of certain results, is the "committee." A committee differs in my mind from a conference in that it usually has definite responsibility and authority and acts by unanimous or majority vote. The committee is a slow way of accomplishing results, but where several branches of an organization are involved and each is responsible for a part of the answer, it is proper under some circumstances that the final decision should be made by a committee in which every part of the organization represented thereon assumes joint responsibility. The race is not always to the swift, and to accomplish our end which we are constantly keeping in sight, in some circumstances a committee is a splendid piece of machinery.

A committee, it seems to me, should always have a chairman. I recall an incident during the war when the Secretary of War appointed a number of committees, each composed of representatives of our army and some of the Allied military representatives who were in Washington. The committees were appointed without chairmen. A most distinguished representative of one of our Allies respectfully suggested to the Secretary that their experience in the war had shown committees to be of little value unless a chairman, or at least a "convener," were appointed. No action was taken, however, and the next day the inevitable happened: the committees failed to meet, no one knew who was to call meetings, and in fact no one was quite sure who his associates were on the committees. It was a very striking example of the failure of committee work to function properly without a chairman or at least a "convener."

ORGANIZATION inherently imposes some restrictions upon freedom. Organization means teamwork, and

teamwork means working for the good of the team. Pride of authorship, desire to be personally in the limelight, any tendency to build up one's own reputation by criticizing or belittling others, are all disastrous to the successful working of an organization. After all, common sense and hard work, combined with a sympathetic consideration for others and pride in the institution will result in each man going ahead as far as his inherent abilities will permit, in spite of the size and complexity of large organizations. "Captains of industry" belong to the pioneer days that are past. Large modern business organizations require executives who are also wise administrators. It is the day of statesmanship in business.

PLOWING CABLES INTO THE GROUND

Unusual Equipment and New Techniques Have Been Developed for Cutting a Furrow and Laying Cables in It as a Single Operation at the Rate of Several Miles a Day

By TEMPLE C. SMITH

This article was originally prepared as a companion-piece to "Engineering the Transcontinental Telephone Cable," which appeared in the MAGAZINE *for November, 1941. It amplifies a paper on a similar topic which was presented before the winter meeting of the American Institute of Electrical Engineers.*

ANYONE harboring an ambition to obtain a basic patent on the art of plowing cables into the ground should acquaint himself with an experience of Mr. Ezra Cornell, the founder of the university which bears his name. This incident in his life, which occurred long before the idea of the university was conceived, is related by former Ambassador Andrew D. White in his autobiography as it was told to him by Mr. Cornell. Back in the early 1840's, so the story goes, Mr. Cornell chanced to meet the man who had contracted to place the first telegraph wires between Baltimore and Washington, and learned from him that he was in grave doubts as to his ability to carry out his contract. It must be remembered that the simple expedient of placing wires on poles had not then been proposed, so that those first historic circuits were to be placed underground. Mr. Cornell offered to build a machine which would dig the trench, lay the "leaden pipe" carrying these wires, and cover it with earth, cheaply and rapidly. He devised such a machine, and demonstrated to the satisfaction of an investigating committee that when "the long line of horses" dragged his "ponderous machine" forward, it really did lay the leaden pipe (cable) under ground.

Apparently, however, difficulties were encountered, for the machine was later abandoned. Many years elapsed before a really successful wire and cable-laying plow was developed and used.

As this article is being written, nearly a hundred years after those first telegraph wires were laid, huge plow trains like the one shown in Figure 1 are doggedly working their way across the Great Plains, laying other history-making wires—the first transcontinental telephone cable. Today, through industrial magic, we find the modern equivalent of Mr. Cornell's

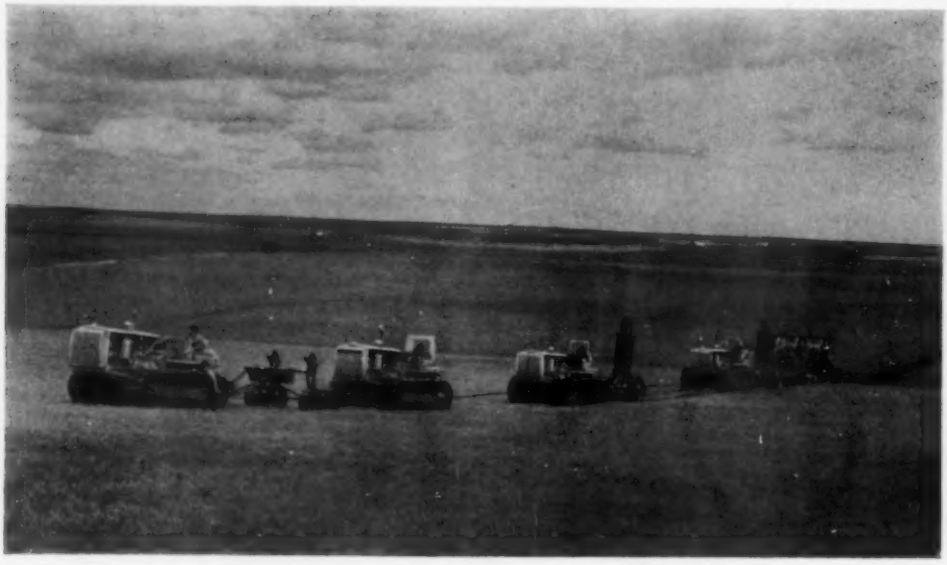


FIG. 1. ACROSS THE GREAT PLAINS

The cable-laying plow train, as shown here, consists of: a 100-horsepower Diesel-engine caterpillar tractor; an empty traction-loading cable reel trailer, used in changing cable reels; two more tractors; a rooter plow; a fourth tractor; the cable-laying plow; and, finally, two reels of cable on winch-loading trailers. The entire train is connected into one unit with a motive force of 400 horsepower and a weight of 100 tons

"long line of horses" in the four great caterpillar tractors, whose deep-throated exhausts bespeak a power undreamed of a hundred years ago!

Similar trains are burying telephone cable in other parts of the country. In fact, to meet the demands for additional toll facilities arising from the nation's emergency program, the Bell System found it necessary to secure equipment for and to train crews to handle ten complete plow trains.

The use of plows for burying cable and wires is not new. In fact, the first Bell System plow was built in Oklahoma some 12 years ago for burying cable there. It could lay cable at a maximum depth of 30 inches. Only recently, however, has been developed which is capable of cutting a slot as much as 50 inches deep, where such depth is needed, and of burying either a single cable or a pair of cables, together with as many as three properly spaced lightning protection wires where they are necessary.

an entirely power-controlled plow

Some of the arrangements used, the principal features of the large units of the equipment, and the attachments employed to meet the varying conditions encountered are discussed in the following pages. It will be evident that to provide apparatus for plowing-in cross-country toll cables has required the design of many pieces of equipment which the word "plow" does not imply.

In the development of each unit of equipment, the matter of safe performance of the work has been given careful thought. The heavy and powerful equipment is new to the plant crews, and special safety precautions must be practiced in its use.

Arrangement of the Equipment in the Plow Train

VARIOUS arrangements of the equipment in the train are made to meet various conditions, in each instance building the operation about the all-important plow. In Figure 1, two identical plows are included in the line in which all plows, tractors, and trailers are connected from one end of the train to the other, either by one-inch steel cables or by direct-acting towing hooks and eyes. The front plow roots through the earth with a 3¾-inch share, loosening and breaking up the ground to a depth of from 30 to 50 inches, thus insuring uninterrupted passage of the following plow, which deposits two cables and the lightning shield wires, all properly spaced, in the ground. This 100-ton train, with its more than 400-horsepower pulling force, moves forward at the rate of a brisk walk, laying the cables and lightning protection wires as it goes. Pauses are necessary only to change cable and wire reels on the trailers and to remove any major obstructions encountered in the ground.

Where the ground is not hard and is free of rocks, and thus there is no danger of interruption to the plow from buried obstructions, the train make-up may omit the rooter plow, as in Figure 2.

On the other hand, it frequently

FIG. 2. VIEW FROM THE REAR

One tractor and the rooter plow are omitted in this train (cf. Fig. 1), since the rooting operation is unnecessary where the ground is free of obstructions

FIG. 3, *left: Where ground conditions are as bad as this, the rooter plow goes ahead, and the cable-laying plow follows as a separate operation.* FIG. 4, *below: Power applied from the single-drum winch of a stationary tractor comes in handy for pulling the train, or any part of it, up hills or out of mud*

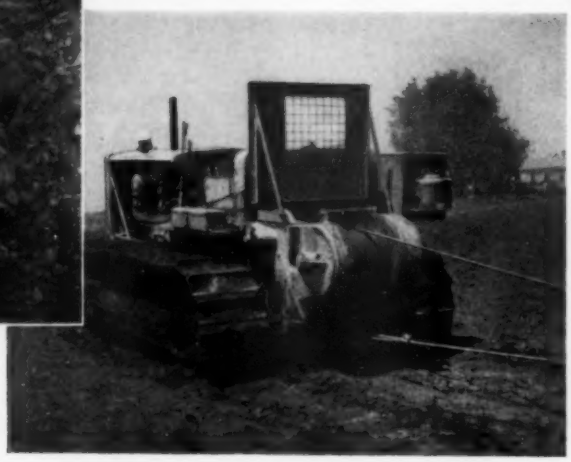


FIG. 5. OUT OF A SOFT SPOT

The heavy steel cable rove through the block attached to the front end of this tractor leads to the power winch and towing bar, as shown in Fig. 4, of a tractor up ahead

happens that more difficult conditions exist, or underground obstructions are known to be present or are suspected —as, for example, when nests of heavy boulders extend down to the bottom of the trench (Figure 3). Here two or three tractors and one plow will first go over the line to root a trench. They are followed, as an entirely separate operation, by another plow train consisting of one or two tractors, a plow, and one or two cable reel trailers, depending upon the number of cables to be placed in the trench.

Winching the Train Out of Trouble

IN rooting or plowing, occasionally the train may become stalled in pulling across a ravine or up a hill. The front tractor, with its powerful single drum winch (Figure 4), runs ahead to firm ground and prepares to "winch out" the train by making a two-to-one pull on the rear tractor, which remains coupled to the plow. (Figure 5.) When this operation is necessary, the driver of the front tractor first puts a tension in the steel winch line and sets the winch brake. Then he grinds the caterpillar tracks into the firm ground, pulling against the taut winch rope, until the tracks are sufficiently "dug in" to give the tractor a firm setting for a pull. Now, with the track brakes set on the front tractor and the winch pulling, and the rear tractor exerting whatever forward traction with its tracks the condition of the ground permits, the train moves ahead.

One caterpillar tractor's maximum drawbar pull is about 30,000 pounds on the level; but in moving up hill the pull is decreased in proportion to the steepness of the grade, since it is necessary, of course, to raise the tractor weight of some 41,000 pounds. With the aid of a double line pull from the heavy-duty winch of the forward tractor, the effort exerted may reach as much as 150,000 pounds. On a well chosen route there are few situations for which this set-up is not adequate.

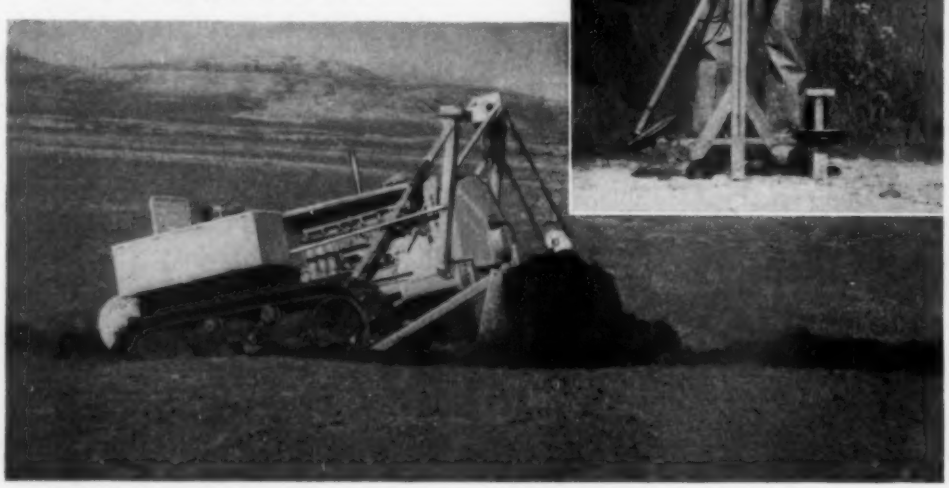
Burying Cable on Steep Grades

BY careful handling of the equipment, cable can be plowed in hillsides even where the grades are as much as 60 per cent. For instance, it has been found to be necessary to bury cable up hillsides such as shown in Figure 6. Here the cable will be buried in the "hog back" leading to the summit where the three poles are silhouetted against the sky. It will be evident that in such territory special attention must be given to selecting locations where cable reels can be changed on the trailers. Distances between locations thus determine the cable lengths per reel.

The preferred method of operation in these mountainside conditions is to root down the grade, leaving a tractor "dug in" on the top, with its winch rope attached as a safety line to the back of the rooter plow as it is slowly pulled down the slope by other tractors. The cable-laying train can be let down grade in the same manner. To obviate the possibility of buried stones wedging at the side of the plow share when placing the cable, the last pass of the plow doing the rooting work is in the same direction as the cable laying plow will take. Since the cable must be laid in continuous

FIG. 6, *left: Cable will be buried in the narrow "hog back" running from the top center in this picture down to the left.* FIG. 7, *below: Aerial photographs such as this, joined and mounted in panels, are of great value in planning the route of buried cable through difficult terrain*

FIG. 8, *right: "Buried treasure" detector—an electrical device which accurately locates underground pipes and cables both laterally and in depth.* FIG. 9, *below: A bulldozer at work. Leveling off sharp dips in uneven ground makes the subsequent passage of the plow train easier*



lengths which usually are about 1500 to 3000 feet each, there may be one or more up and down grades in one cable length, thus making necessary the pulling of the cable plow train up grade as well as down. Here again the trusty winch is brought into action after the tractor has been placed in a strategic position at the top of the hill.

Selecting and Preparing the Right-of-Way

Now that we have seen something of what the plow train is like and how it can winch itself out of difficult situations, let us go back in the sequence of the operations and see how the route for the buried cable is selected, surveyed, and explored so that the work of preparing the right-of-way can be started.

When it has been determined that a buried cable will be required between two points, possible routes are explored to establish the best location, keeping in mind such factors as accessibility, estimated cost of the construction, nature of the terrain, plant of other utilities, cost of right-of-way, and future developments. In rugged country this initial survey of the route may be made with the assistance of aerial photography. The airplane survey pictures are carefully studied through special lenses which give a three dimensional effect, and remarkable detail is afforded by the present-day photographic and viewing equipment (Figure 7). The relative heights of trees and buildings stand out with all the clarity of the old-time stereoscope. Since private right-of-way is generally followed, often over very rough terrain, the use of this ideal method of route selection is often found to be worth while.

The tentative route laid out on the aerial survey picture is now explored on the ground by engineers. Ordinarily the route goes across fields, woodlands, mountains and streams, but always consideration is given to accessibility from the highways, and to the other factors which have been mentioned. This is important for both the ease of installing the cable and maintaining it in the future.

Information regarding soil conditions and underground obstructions is very valuable in planning the route. Sometimes oil and gas pipe lines are encountered. Experience indicates that there are many pipes in the ground regarding which there are no accurate records—and in many cases no records at all. These underground pipes have to be located both as to where the proposed route crosses them and as to their depth, because the plow is sufficiently rugged and the tractors have ample power to snap a good sized underground pipe in two. This method of striking oil is not to be recommended.

On one 83-mile run there were 91 crossings of oil pipe lines at the time of the survey. Before the work was done, in a few months, four new pipe lines had been gained and three old ones lost. By the use of suitable apparatus, underground pipes and cables can be readily located without excavating. There are commercially available vacuum-tube type locators which indicate the vicinity of buried cable or pipe. To determine their exact location, a triple coil electrical detector developed by the Bell Tele-

FIG. 10, *right: A bulldozer has already opened up a passage for the plow train in the bank of this creek.* FIG. 11, *below: Crossing a road at an angle often obviates cutting away shoulders or banks*

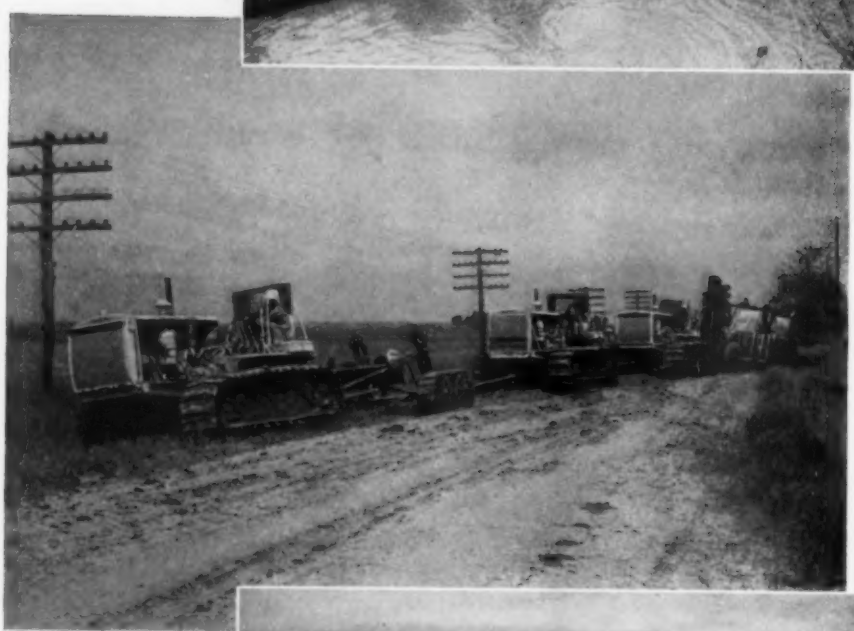


FIG. 12. *A bulldozer "eased off" the sharp drop of the ditch banks in preparation for a square crossing of this road. Road surface and shoulders and ditch banks are always restored to their original condition*

phone Laboratories may be used (Figure 8). This device, which is primarily for locating cables, can be used also in exploring for buried pipes. It is so accurate that an underground cable can be located within less than an inch both laterally and in depth below the surface.

Through use of the information accumulated by the methods discussed, the line of the proposed buried cable can now be staked out in readiness for the work crews. Buried boulders, ditches, and other obstacles interfere with the cable-plowing operation. Whatever preparatory work can be done to prevent delays to the rooting and cable-plowing crews helps to "keep the train moving."

Preparing the Roadway for the Plow Train

ONE of the first jobs to be done in opening up the cross-country roadway is to build gates in all the fences encountered. These are necessary for future maintenance as well as for the passage of the cable-laying train.

At sharp ravines, road ditches, and stream banks, a roadway is made by a caterpillar tractor operating with a "bulldozer," as shown in Figure 9. A creek crossing as in Figure 10 becomes quite simple and no delay is involved if the bulldozer has first cut a road through the banks. It might be noted in passing that at such locations, if there is any danger of the cable being disturbed later by road construction work or earth washing, the cable is plowed in at full 50-inch depth and, to afford maximum protection, a covering of steel or creosoted wood is sometimes placed over the cable.

At road crossings such as is shown in Figure 11 the ditches may be shallow and the crossing made at an angle, so that it is not necessary to prepare a roadway crossing the ditch banks. Where the crossing is square and the ditch banks steep, as in Figure 12, it is desirable to ease the drop in order to facilitate pulling the train across and to minimize the tilting of the plow with the attendant tendency to raise the bottom of the share, thus laying the cable at a too shallow depth.

The plow operates satisfactorily across gravel and macadam roads as well as those which are not surfaced. After passage of the plow, the disturbed ground in the roads and the ditch banks is carefully restored to its former condition, thus preventing erosion.

The caterpillar-tractor-operated bulldozer, or its close relative the trailblazer, is useful in preparing a roadway where it is desired to plow-in the cable along a hillside instead of up or down the hill. It is not safe to operate the train on more than about a 10 per cent side grade, due to the tendency of the pulling tractors as well as the plow and trailers to slide down hill. On such side-hill grades the winch is again useful in minimizing the tendency of the train to slide to the down-hill side.

OF course, in wooded country a roadway must be prepared for moving the cable reels and equipment along the right-of-way as well as to clear a place to plow.

On private right-of-way an easement on a strip of ground about one rod wide is ordinarily secured, anticipating the possible future need of

FIG. 13, *above: Only the winch power of the head tractor makes possible the plowing-in of cable here.* FIG. 14, *left: Oak "swamp grousers" on caterpillar tracks increase the supporting surface.* FIG. 15, *below: The skid under the plow helps to support the down thrust of the tongue*

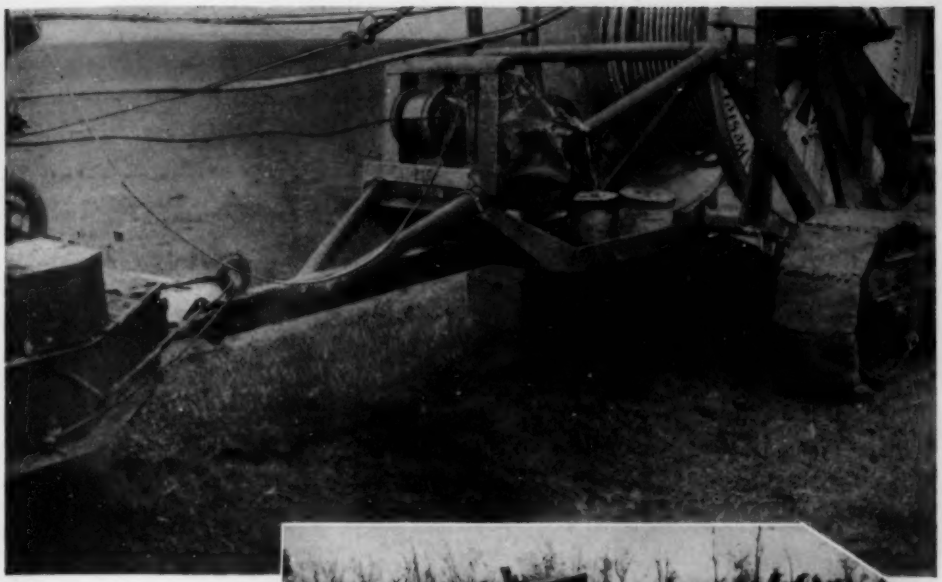


FIG. 16, *above: The skid under the trailer gives additional support over soft ground.* FIG. 17, *right: Here the problems are depth and density of mud, weight of equipment, supporting area, and winch power.* FIG. 18, *below: The plow continues to bury cable as it is winched across the river*

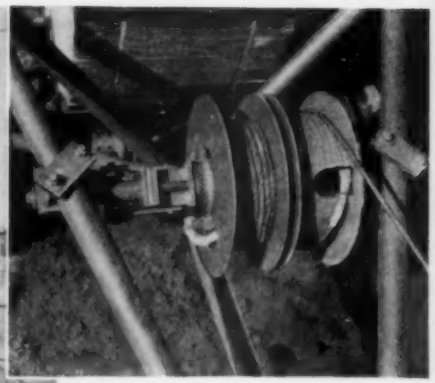
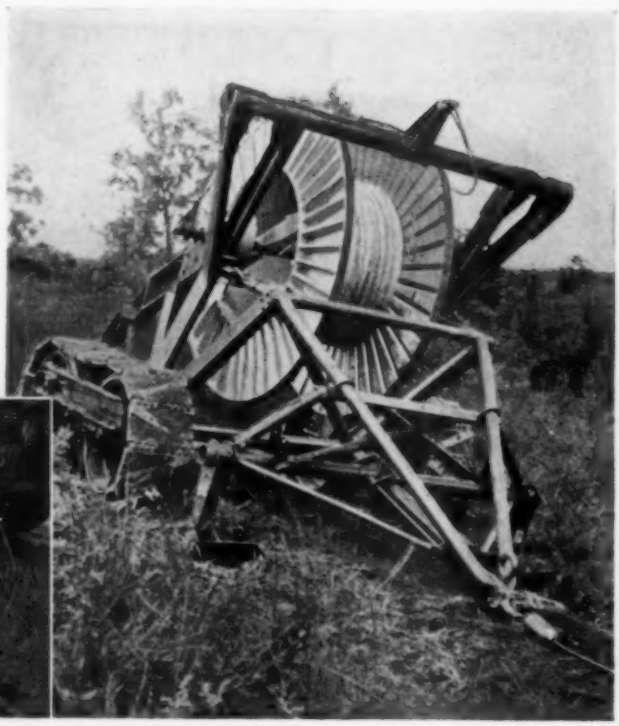
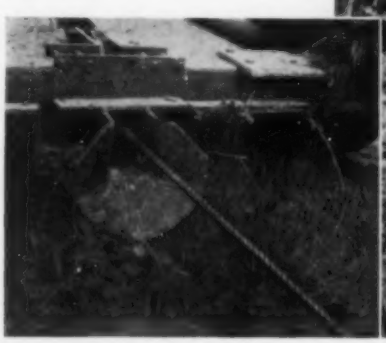


FIG. 19, *left: A multi-drum winch on a tractor. It is used for adjusting the depth of the plow, loading cable reels, and moving trailers.* FIG. 20, *above: This relay winch pulls the tongue end of the rear trailer into a special keeper which serves as a coupling. Paying out the wire rope permits the trailer to drop behind*

FIG. 21, *right: Release of the relay winch has halted the rear trailer. The bullet-nose connector is shown at the end of the trailer tongue, at the lower right.* FIG. 22, *below: This keeper, under the axle of the front trailer, receives the bullet-nose connector, which is held by tension on the rope from the tractor ahead*





a second buried cable. A passageway at least 10 feet wide is cleared, and at reel change points additional width is required to maneuver the equipment. The 10-foot width will permit passage of the train in rooting and plowing. However, unless the cost of clearing an extra three feet of right-of-way is excessive, it is very desirable to have a 13-foot passageway so that the 8½-foot-wide tractor can be used for tamping, as will be discussed later. Where practicable, the trees within the proposed plow-trench area are pulled out by the roots in order to eliminate the interference with plowing which the roots would cause, and also in order that the roots may not conduct lightning to the cable.

Crossing Swamps

IT has been necessary in a few cases to bury cable across marshy ground or swamps (Figure 13). This has presented a difficult problem. However, because of the use of specially designed equipment and appropriate methods, there have been no cases where the heavy cable-plowing equipment has disappeared in the "black bog," never to be seen again, as did the helpless Carver in the story of Lorna Doone. It is gratifying to relate that all swamp jobs yet attempted, even those in the very soft and seemingly bottomless Dismal Swamp at the southeastern tip of Virginia, have been successfully completed.

Attaching "swamp grousers" made of overhanging, bolted-on oak cleats, to the caterpillar tracks (Figure 14) has helped materially, although if these alone were relied upon and an attempt were made to pull the train with the tractor tracks, a grave would be quickly dug for the machine. However, the tracks so equipped do permit maneuvering the tractor across a marsh, thus obviating traveling long distances to find firm ground or roads. In this manner the tractor can be quickly run ahead and located for a winch pull from firm ground or, if this is not available, with the front end anchored to some stable object.

For swamp work the plow tongue is supported by a special steel skid. In Figure 15 the skid seems small because of the large equipment with which it is associated. Actually it is 3½ feet wide and 11 feet long. When it is operating on mud, a large skid is placed under each wheel in order to give the plow better bearing surface to carry the load than is provided by the 12.75 by 24-inch pneumatic tires. Also, there are large bearing plates under the framework of the plow. In addition to the bearing surface furnished by the caterpillar tracks of the cable reel trailers, a large bearing plate extends from the middle of the tongue clear back to the under side of the axle, as shown in Figure 16.

By such expedients as these, the unit bearing pressure on the mud for each unit of the cable-laying train is so reduced that the train can be slid over the soft surface, while at the same time depositing the buried cable and wires at the proper distance beneath the surface (Figure 17).

Crossing Streams

THE technique followed in crossing some types of streams is similar in many respects to that used in negotiating marshy ground. However, if the water is deep, it may be necessary for the tractor to detour to shallower wa-

FIG. 23, *above: Loading a reel of cable onto a trailer. The yoke is being pulled up by a line from a multi-drum tractor winch, and the latches will catch the spindle after another foot of travel.* FIG. 24, *right: The share of the cable-laying plow is in its upper position, so that the cable can be fed through it at the start of a laying operation.* FIG. 25, *below: This is how twin cables feed out through the foot of the plow share and are pulled through and staked before the train moves ahead*

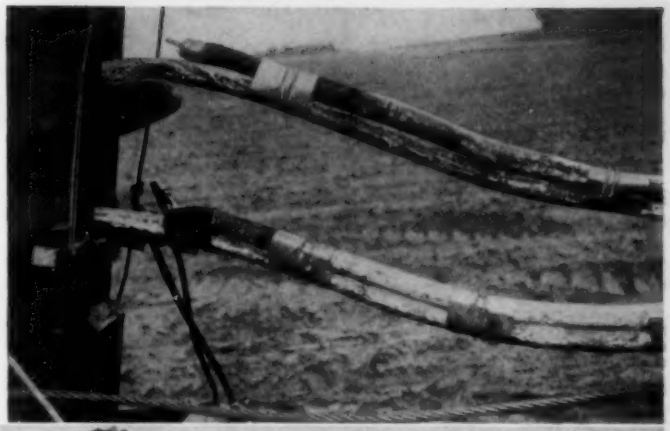


FIG. 26. *Each succeeding cable is clamped to the end of the cable ahead, in order to pull it into the plow share*

FIG. 27. *Guiding clamped cables into the plow share. Cables must enter the share in proper position to obviate binding*

FIG. 28. *Lightning shield wire bracket. It is often necessary to bury properly spaced lightning-protection wires in the same furrow with the cable*

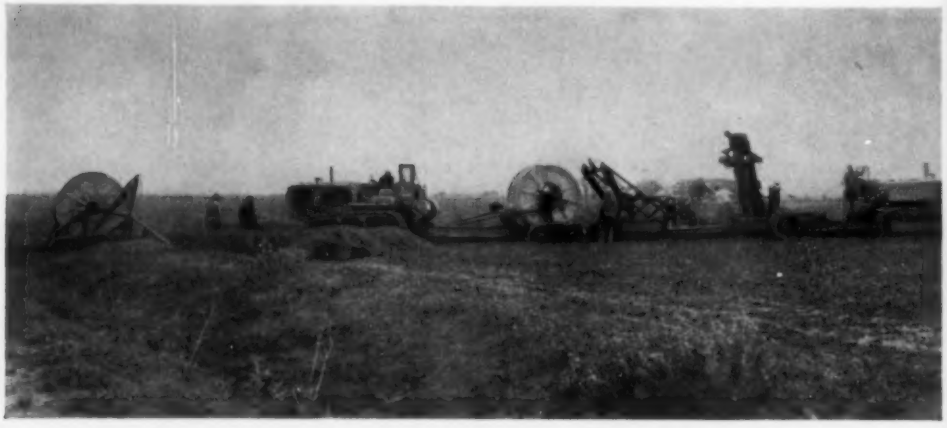


FIG. 29. CHANGING REELS ON THE FRONT TRAILER
The train must be broken in order to get a full reel of cable to the front trailer and remove the empty reel

ter or by the nearest bridge. It may be found desirable also to root across before laying the cable under the stream, whereas in the soft marsh the rooting may not be necessary (Figure 18).

If the cable plow is started on one river bank in the trench previously cut by the rooter, and the winch line pull is made from the same position each time, the plow will ordinarily follow the rooter trench. In some cases of this sort, the plow and trailer equipment have been almost completely submerged.

Important Features of Operation of the Plow Train

THE caterpillar tractor placed next to the plow in the train is equipped with a 4-drum winch (Figure 19) with independent lever controls conveniently located for the tractor driver so that he can exert a pull up to about 6000 pounds on any one or more of the four winch ropes.

Two ropes feed to pulley blocks at the base of the tower of the plow. One of these ropes pulls the plow share up to reduce its depth or to raise it entirely out of the ground. The other pulls the share into the ground, thus adjusting the cable depth to the desired position, where the share is locked. Depth markings of from 20 to 50 inches can be seen on the tower frame member in several of the pictures.

A third rope feeds to a new type "relay winch" mounted in the tongue of the front trailer (Figure 20), for use on dual cable jobs. It pulls the bullet-shaped connector at the tongue end of the second trailer (Figure 21) into its keeper under the axle of the front trailer (Figure 22). By this method of releasing the rear from the front trailer and of reconnecting it, the operation can be accomplished safely, quickly, and easily even though the coupling parts may be under water or mud. Also, the rear trailer is always under control, even when the

coupling is released, by virtue of the steel rope from the bullet connector leading through the keeper under the axle of the front trailer and finally being secured by the relay winch. As mentioned later, this feature is necessary to permit changing empty for full reels of cable.

The fourth rope from the multi-drum winch leads to the arm of the reel-lifting yoke on either cable trailer, as shown in Figure 23. Pulling the yoke forward raises the loaded cable reel, which may weigh as much as 10,000 pounds, into the traveling position, where the reel spindle is locked. Reversing the operation and gradually paying out the winch line lowers the empty reel from the trailer.

Feeding Cables and Wires into Plow

In starting a dual cable job, the plow share is raised to the top position, as in Figure 24, and the cable ends are fed into the back of the share until they emerge from the opening at the bottom (Figure 25). The cable ends then are secured against movement along the ground, the share is gradually lowered to depth during the first few feet of travel, and the plow train moves forward for 1500 to 3000 feet, thus laying the two cables at the desired depth and leaving both reels empty.

The empty reels are lowered from the trailers and full reels loaded. Now the new cable ends must be fed through the plow share. This is done by connecting each new length of cable to the one which has just been placed, by overlapping the ends and binding them together (Figure 26). As the plow train now starts on the next installation, the connected ends are guided into the share and one cycle of operations has been completed (Figure 27).

Where lightning shield wires are required, the reels of wire are carried on a bracket at the top of the plow tower, as in Figure 27, or on the front trailer (Figure 28), and fed to the top of the tower as shown in Figure

FIG. 30. CHANGING REELS ON THE REAR TRAILER

After the empty reel is lowered from the trailer, the new reel of cable is picked up directly from the service trailer which brings it into position

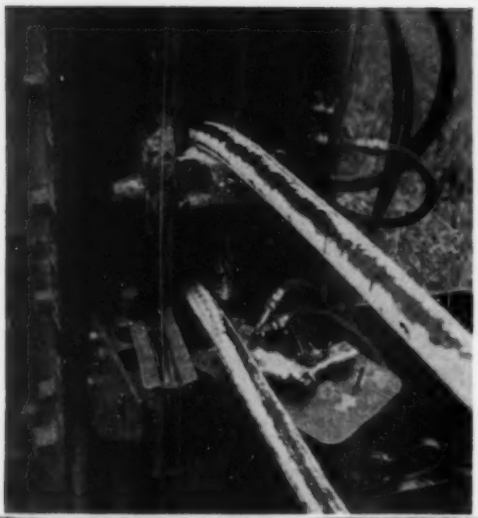


FIG. 31, *left: Oil is sprayed on the cable as it enters the plow, to reduce friction. About four gallons of oil per mile is applied by the spray gun seen at the right of the lower cable.* FIG. 32, *below: This shows the coupling between tractor and plow, released. When the shear pin—with a breaking point of 72,000 pounds—snaps, the heavy tubular guides hold the tongue in place so that recoupling may be quickly done*

FIG. 33. *Back-filling is part of the cable-laying operation. A device under the rear trailer mounds up the earth over the furrow, and a tractor runs over it when bringing up a new reel of cable*

24 and thence through special ducts in the share to the desired locations in the ground. This operation takes place, of course, simultaneously with the cable plowing.

Changing the reels is necessary for every cable length, usually at 1500- to 3000-foot intervals. Where only one cable is being laid, this is a simple matter; but where two reels are involved, the changing of the front one presents some difficulties, as can be visualized by referring to Figure 2. The rear trailer completely blocks the operation.

In order to leave space between the two trailers, thus permitting the front one to be loaded, the rear trailer is dropped from the train as it moves along, about 50 feet before the cable-end leaves the rear reel. This is accomplished by releasing the relay winch, thus disconnecting the rear trailer from the train, just as the engineer of a switching locomotive might drop a car from his train. The front trailer is now accessible from the rear so that the empty reel can be lowered from it (Figure 29). A tractor with a third trailer now moves a full reel to the front trailer and it is loaded. The relay winch comes into action at this point to pull the rear trailer with its empty reel up to its working position, where it is automatically coupled in the train, after which it receives a new reel full of cable, as shown in Figure 30.

Lubricating the Cable

THE buried cables ordinarily used range in size from one to 2½ inches in outside diameter. However, cables as large as 3.2 inches in diameter may be used by employing a wider share, which the plow is designed to accommodate. Usually the cables are covered with a jute wrapping, under which, in gopher infested territories, there will be steel tape surrounding the conventional lead sheath. In some cases a thermoplastic rubber covering with a burlap wrapping is used instead of the jute.

But asphalt-impregnated jute covering and the impregnated burlap develop comparatively high coefficients of friction against the steel walls of the rectangular tube through which they pass while in the plow share. When two cables are buried, the top one in the ground may show a tension as high as 5000 pounds as it is being pulled through the share. This tension is objectionable for electrical as well as mechanical reasons.

In order to obviate this difficulty, an oil spray apparatus is used, from which a constant spray of oil impinges upon the lower side of the bottom cable as it enters the plow, thus reducing the tension in the cable to a safe maximum of less than 1000 pounds (Figure 31).

The Safety Shear Pin

WITH two or three powerful tractors pulling in series formation, what happens if the extremely rugged rooting plow hits, let us say, a buried ledge of solid rock? The plow is an integral part of the very heavy, briskly moving rooter train with its combined tractor pull of 200 or 300 horsepower. Recollections of the school-boy poser about the irresistible force and the immovable body come to mind.

Figure 32 shows the result of such an occurrence. A large safety shear pin, which releases at 72,000-pound

pull, is located in the front of the plow tongue. It has just sheared, and the telescoping tubes have permitted the tractors to move forward until they can be stopped by their operators. The tractors will be backed until the tow bar enters the hole in the end of the plow tongue, a new shear pin inserted to hold it in the hole, the share raised sufficiently to clear the obstruction, and then the plowing will proceed. This operation requires less than two minutes' time from stop to start and can be done easily even under water or in mud. The shear pin, like a fuse in an electrical circuit, saves the equipment from damage.

Backfilling and Tamping

SOME soils, especially moist sod, are not sufficiently disturbed by passage of the plow share to require backfilling. Under other conditions the surface of the ground may be heaved from caterpillar track to caterpillar track by the 3¾-inch-wide share with extra ducts, familiarly known as "blisters," on the sides to carry the lightning shield wires. In Figure 33 is shown the result obtained under such a condition with the V-shaped backfiller under the rear trailer. A good job of tamping is done by running a caterpillar tractor so that its tread passes along first one side of the ridge and then the other. This may be done as an incidental operation by the tractor which handles empty and full reels.

The clatter of the several Diesel engines makes vocal signals impossible. This condition is met by such a device as the tractor exhaust whistle,

FIG. 34. SALTY RIGHT-OF-WAY

The transcontinental cables will be plowed into the salt bed at the left of the roadway, which adjoins the automobile speed-record course near Great Salt Lake

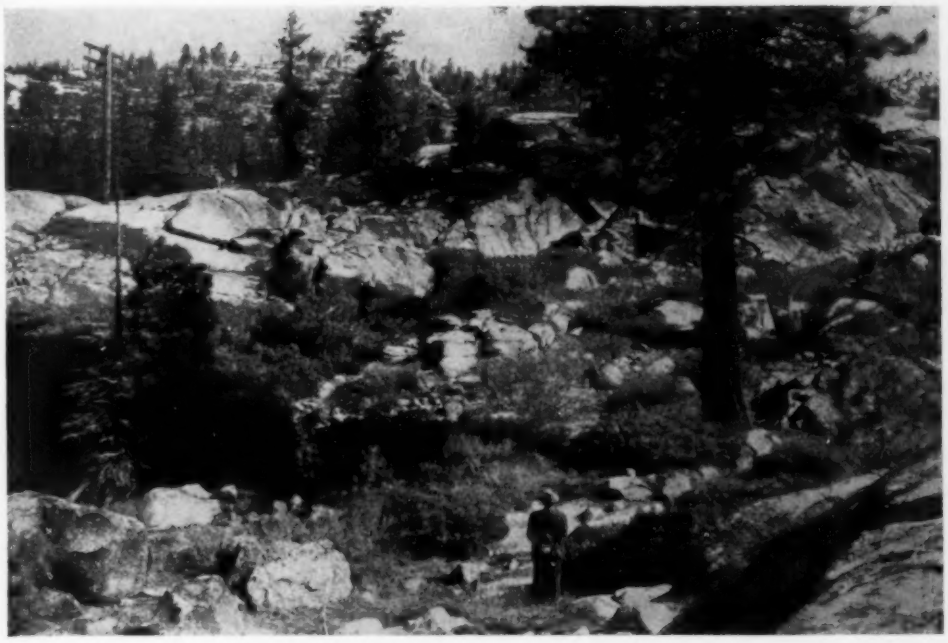


FIG. 35. NO CABLE PLOW GOES HERE

In this solid granite of the High Sierras, a trench for the transcontinental cables will be prepared by chain blasting

which can be blown by cords hanging at either side of the plow. Particularly when a quick stop is required, a loud signal must be used to reach the drivers of the noisy caterpillars which are ahead, as well as the near one.

UNDER ordinary conditions it is possible to place about 17 trench miles of cable per 5-day week with this equipment. This would mean that a foreman with his crew of about eight men, on a dual cable job, might, in a week, bury 34 miles of cable, together with whatever lightning shield wires are required.

Conditions vary widely, from the prairies with their black loam and clay to the steep mountains, or the soft marshes, or to soil sown thick with boulders. The mileage of cable buried daily naturally will correspond to the conditions encountered.

Burying Cable by Other Methods

BECAUSE of its speed and economy, the plow train is used wherever practicable for burying cables, and this covers all but a very small percentage of the buried cable work.

In extremely rough mountain territory some right-of-way may be too steep or rocky or inaccessible for the plow train, but it is surprising how relatively small is the footage even here which cannot be economically plowed. For instance, on the proposed transcontinental cable line, there was some question whether the

plow could be used in the ten miles of hard salt beds shown at the left of the highway in Figure 34, adjoining the Bonneville automobile racing flats in Utah. However, in exploratory trials at this location, the plow rooted through the hard salt beds very satisfactorily.

On the shorter projects, trenching machines are employed to a considerable extent, and also on a few of the major undertakings where conditions are particularly favorable to their use.

In connection with cable-plowing, several variations of the plows and associated equipment have been tried in the course of the development of a satisfactory plow train. While experimental devices are of course under trial now, the units described in this article represent types which have proved satisfactory and are currently in general use.

There are some locations in the High Sierras where a relatively small portion of the Sacramento-Reno buried cable run must cross areas of practically solid granite (Figure 35). Here the engineers plan to prepare by chain blasting a narrow shallow trench in which the cables will be laid. The trench will then be filled with an asphaltic material which will hold its position, keep water out of the trench, and protect the cable.

IN an article such as this, only the major operations and the principal items of equipment can be mentioned. Many others have had to be developed in order to make the use of buried cable broadly applicable. There are the jobs of passing under concrete arterial highways where the pavement cannot be disturbed and the soil may be either earth or rock. There is the matter of finding a way to cross under rivers too swift and full of boulders for submarine cable and having granite beds which cannot, of course, be plowed. There is the matter of avoiding buried pipes and other obstructions. These have been interesting problems in themselves—of whose solutions there is not space to write here.

Most spectacular will be the plowing-in of certain parts of the Omaha-Sacramento transcontinental telephone cable, which, upon completion late this year, will provide the first all-cable link between the eastern and Pacific Coast toll telephone networks. That is only one part, however, of the program of underground cable extension which the Bell System is now carrying on—a program which is being speeded to the utmost to keep abreast of the mounting demands for telephone service being imposed by the national emergency.

What has been told here is but one chapter in the story of the System's continuing search for better ways of doing the job entrusted to it; the job of furnishing telephone service for the nation under all conditions. The methods and equipment used in plowing telephone cables into the ground, here described, are the result of planning, designing, and testing; and have had as their objective the provision of more and better and safer speechways for the voices of a people habituated to rely on the telephone for swift communication of their thoughts and needs.

THE FUTURE OF TRANSOCEANIC TELEPHONY

Submarine Cables, with Integral Vacuum-Tube Repeaters at 40-mile Intervals along the Ocean Floor, Are Contemplated as Supplementary to Existing Radio Telephone Circuits

By OLIVER E. BUCKLEY

When Dr. Buckley, who is President of the Bell Telephone Laboratories, was invited by the Institution of Electrical Engineers (of England) to deliver the thirty-third Kelvin Lecture in London last April, not only was a notable honor conferred upon him, but the accomplishments of the Bell System in electrical communication were thus given recognition.

Lord Kelvin, in whose honor the lectureship was established, was one of the great physicists of the nineteenth century. He made many contributions to both fundamental and applied science; and of the latter, none has received greater public recognition than his development of a transmission theory for application to the second transatlantic telegraph cable (1866) which made of it a success where its predecessor had been a failure. This is regarded as perhaps the first great achievement in what is now the highly developed science of circuit analysis. In the light of this situation, the subject-matter of Dr. Buckley's paper is particularly appropriate.

In the first portion of his address, which is omitted here, Dr. Buckley reviewed the frequency-band requirements of various forms of electrical communication, described the development of transatlantic radio telephony, and commented on the application of magnetic loading materials to undersea telegraphy which has multiplied by four the traffic capacity of modern cables. Information gained in that work was in turn applied to the problems of submarine cable telephony, and in 1930 a short experimental section of such a cable was actually manufactured for the Bell System and was tested at sea. Advances in transoceanic short-wave radio telephony, and the business depression of the 1930's, made the possibilities of that cable less attractive and, although it appeared technically sound, the project was not carried beyond the experimental stage.

Since Dr. Buckley was unable to journey to London to deliver the lecture himself, he had a brief sound-picture of greeting recorded. After he had appeared on the screen before his audience in London, his paper was read by Sir Stanley Angwin, Vice-President of the Institution. The latter portion of the address follows.

THE EDITORS

To predict the future development of transoceanic telephony is presumptuous, to say the least. So rapid has been the advance in the art of communication and so revolutionary have been the dis-

coveries in this field that one is quite unwarranted in setting any limits to the progress that may be achieved. However, there are some developments that have progressed far enough in the laboratory to discuss with reference to their early application; also there are pertinent indications as to the future of transoceanic telephony apparent from consideration of developments which have occurred in long-distance overland telephony.

Perhaps the most significant recent development in land-line telephony is that of broad-band transmission over open wires, cables, and coaxial conductors. Broad-band transmission means the transmission by carrier methods of a considerable group of telephone bands on closely spaced channels. Over open-wire lines and over pairs in lead-covered cables, 12 telephone bands spaced at 4000-cycle intervals are commonly transmitted in a group occupying a total band width of 48,000 cycles. With coaxial conductors, the band has been increased to 2,000,000 cycles, giving frequency space for some 500 telephone channels, and it may be expanded still further when more channels are required.

Broad-Band Methods for Trans-Oceanic Telephony

THE application of broad-band methods to transoceanic radio telephony may be anticipated with some confidence. To achieve it requires broad-band amplifying systems capable of delivering high power without distortion. Commercial success has already been achieved with small numbers of channels in the Holland-East Indies and the United States-England single-sideband systems. More recently, by applying the principles of negative feedback, Bell Laboratories engineers have developed a short-wave transmitting amplifier of 200 kw capable of handling 12 or more closely spaced telephone channels.

One might visualize the broad-band transatlantic radio telephone system of the future as being built up of successive groups of these 12-channel blocks. The number of groups that might be used simultaneously is, of course, limited. Over any path where radio transmission depends upon reflections between the ionosphere and the earth, Nature sets a rather definite limit on the range of frequencies that is usable at any given time. In effect, there is provided a transmission path between transmitter and receiver which is capable of passing a broad but nevertheless limited band of frequencies. Frequencies above this band are not consistently returned to earth from the ionized regions. Frequencies below this range are absorbed. The high-frequency end is marked by a sharp cut-off, while there is a more gradual diminution of effectiveness at the low-frequency end. The position in the spectrum of the useful band shifts with time of day, season of the year, and phase of the solar cycle. Its width varies, too, being narrow at night and wider during the day.

Thus, for example, when the sun is over the mid-Atlantic in summer there is available a useful band of frequencies about 4 megacycles wide, extending from about 14 to 18 megacycles. It is not sharply defined on its lower side, and its position in the spectrum

varies with the season of the year and the sunspot cycle. But we may say roughly that nature provides at any one time, at least during the most useful hours of the day, a band width of the order of 4 megacycles. If this entire range could be utilized for telephony over this particular path, and were subdivided sharply into telephone bands of 4 kilocycles width, there could be realized 1,000 telephone channels. These might be used in any of the several ways, as to two-way transmission and as to the points at which they terminate.

BUT public service transatlantic telephony is not the only service requiring these important short waves. There are many other uses of them, such as radio telegraphy, ship-to-shore telephony, airplane communication and navigation, and overseas broadcasting. There are also other natural barriers than the Atlantic to be bridged in this manner, and these short waves, because of their world-wide effect and despite the directivity that can be imparted to them, cannot be counted upon to be duplicated very often for simultaneous use at different locations throughout the world. So we must allow for the available 4 megacycles to be divided to meet a large number of requirements, perhape none more important than the Atlantic route, yet collectively of great consequence. Let us say that, in view of all the other requirements, public service telephony across the Atlantic deserves something like a tenth of the total facilities in this band. This would mean an allotment of 400 kilocycles or 100 one-way telephone channels, yielding 50 or more two-way circuits realizable under the natural limitations of the medium and the other requirements placed upon it.

Of course, the demand for such a number of transatlantic telephone circuits will depend in large measure upon the economy with which they can be realized, but the estimate serves at least the purpose of pointing out that short waves can provide physical facilities for a volume of telephone communication far beyond that now obtaining. Surely we can anticipate with confidence a great growth of transatlantic telephone traffic, but in proportion as the demands for service grow and we come closer to the realization of the ultimate physical possibilities, the more serious becomes the threat of interruption to this service by magnetic storms.

The Transatlantic Telephone Cable as an Auxiliary

THESE conclusions lead us to reconsideration of the transatlantic telephone cable as an auxiliary to short-wave systems. It is readily apparent now, however, that a single-channel cable such as we projected in 1929 would be of little value in supplement ing a radio telephone service of so many channels as there may be in the future. To be of any real value in this situation, the cable also must be capable of carrying a considerable group of telephone channels. It was toward such a possibility that we turned when the project of a single-channel cable was suspended. We have made considerable progress in that direction, and I would like to tell you about it, if you will excuse my presenting a proposal which has still many elements of speculation in it.

It was obvious at the start that a multi-channel telephone cable to cross the ocean would have to be provided with intermediate repeaters, since even a single-channel cable without repeaters required going to practical extremes in structural design. Consideration of mechanical difficulties ruled out locating the repeaters elsewhere than on the ocean bottom. Problems of laying and lifting made it obvious that the repeater housing should, if possible, be incorporated within the cable structure and treated as a part of the cable rather than as an appendage to it. Hence we were led to develop a small-diameter cylindrical housing to be incorporated as a part of the cable underneath its armor. The whole structure had to be flexible so that it could be bent around a cable drum and passed over the bow or stern sheave of a cable ship.

THE structure of the repeater housing which was devised comprises first a succession of pressure-resisting steel rings each having a diameter of about 1½ inches and a width of three-quarters of an inch. Over these is slid a succession of thinner steel rings of the same width but so placed as to overlap the joints of the inner rings. So assembled, the rings form an articulated cylinder about seven feet long. To exclude water, there is placed over this cylinder an annealed copper tube with water-tight seals at its ends. The details of the seal are of the greatest importance. It combines a strictly hermetic seal, in which the conductors are brought out through glass, with a plastic seal through which diffusion of water vapor would be extremely slow, should the glass seal fail. Joined to the copper cylinder, and extending over the cable core for several feet, is a tapered copper sheath which serves to distribute bending strain and protect the conductor joint at the seal. Containers of the type described have been tested at pressures considerably higher than would be encountered in a transatlantic cable. They have also been subjected to repeated bending around a six-foot drum without failure.

Within the repeater housing the elements of the repeater are separately contained in plastic cylinders about six inches long, loosely fitting inside the inner steel rings. Connections between these units are made with flexible conductors.

Power for the Repeaters

A REPEATER must, of course, be supplied with power and, as it is impracticable to provide a primary source of power in such a small housing, power must be fed to the repeater over the cable from a direct-current supply. The supply voltage is one of the limiting considerations in the design of such a cable system. It must not be so high as to endanger the insulation of the cable or repeater elements. An operating potential-to-ground of 2000 volts oppositely poled at the ends of the cable was assumed. Power would be supplied on a constant current basis so that fluctuations of earth-potential would not cause variations of current-supply. The repeater elements were designed to withstand the anticipated voltage-to-earth. Tests of cable-core and joints over a long period of time have shown no observable change under this impressed voltage.

The difficulties of lifting a deep-sea cable for repairs are such as practically to prohibit frequent access to the repeaters for maintenance. Hence, the repeater must be provided with elements which will rarely, if ever, require attention. A period of 20 years without replacement of parts was assumed as a reasonable requirement.

Vacuum-tube Problems

THE problem of life and maintenance is principally the problem of a rugged long-lived vacuum tube. Ordinary vacuum tubes have limited service-life on account of evaporation of material from thermionic cathodes. By making the level of transmitted signals relatively low, the space current may be kept very small. By making the cathode surface relatively large, this small current can be obtained at a temperature so low that the cathodes of the tubes may be expected to last for a very long time.

This is a different approach to the tube problem than has ordinarily been made. New types of tubes based on these principles were developed and put on life tests more than five years ago. As yet they have shown no evidence of deterioration, and one now may be reasonably sure from their behavior and from physical considerations of a life of at least ten years. There is good reason to think that they should last several times that long, but further observation will be required before a life of as much as 20 years' steady operation can be confidently predicted. The tubes must also be more rugged than ordinary vacuum tubes since the cable will be subjected to considerable vibration and perhaps to heavy blows in the course of laying and lifting, though the tubes can be protected to some degree by resilient mountings.

Other elements of the repeater structure, such as coils and condensers, are also subject to special requirements both electrical and mechanical. These requirements have been met in a preliminary way and the assembled repeater in its housing subjected to mechanical tests in the laboratory.

Although the electrical requirements of such a cable are very severe, there are some respects in which the submarine telephone repeater is simpler than a land-line repeater. The temperature at the bottom of the ocean is nearly constant; consequently, the repeater does not have to be regulated to compensate changes of cable characteristics with temperature. Also, once the cable is laid, it is in a very quiet place, and except in shallow water near shore is not likely to be disturbed. True, the electrical characteristics of the cable may show effects of aging, but over a long period of time changes are not great, and they can be allowed for by providing some margin in the electrical design.

IN the circuit of the repeater the heating filaments of the amplifying tubes are placed in series with the central cable conductor. The fall of potential through the heater filaments provides the plate potential for the tubes. Appropriate networks compensate for variation of cable attenuation with frequency. A negative feedback circuit gives a high degree of stability over a wide band of frequencies and minimizes the effect of variations of

tube characteristics. It is interesting to note that the amplification provided by a single tube could drop to a tenth its normal value with scarcely appreciable effect on the performance of the repeater.

The number and spacing of repeaters depends of course on the length and design of the cable. For a cable 2000 miles long to connect Newfoundland and Great Britain there was calculated a core comprising 516 pounds of copper per mile insulated with 370 pounds of paragutta, surrounded by a return conductor of 600 pounds. This is like the core of the 1930 Key West-Havana telephone cable but somewhat smaller. Paragutta was assumed as the insulating material because of extensive experience with it. By using for the calculation the characteristics of one of the newer synthetic insulating materials a somewhat more favorable design would have been obtained. On this cable 47 repeaters spaced 42 miles apart would provide for the transmission of a band 48,000 cycles wide.

Two One-way Cables

THE repeater is a one-way device and to provide two-way conversations two cables have been assumed, one directed eastward and the other westward. This is the simplest solution of the two-way problem but it is not inconceivable that the problem could be solved with a single cable. Using two cables, each transmitting 48,000 cycles, the number of telephone circuits will depend on the band assigned per channel. If we adhere to the present best land-line practice, and assign 4000 cycles per channel there would be room for 12 telephone circuits. For a small sacrifice of quality the number could be materially increased. Even as many as 24 fairly satisfactory circuits could be provided by assigning only 2000 cycles per channel.

Although in Bell Laboratories we have gone a considerable distance in the design of a broad-band repeatered submarine telephone cable, and have developed many of the essential parts, I would not wish to give the impression that all the problems of such a cable have been solved, or that the time has come to proceed with its construction and installation. Indeed, it is only by building trial sections of such a cable and subjecting them to repeated punishment more severe than a cable is likely to encounter, that the problems can be fully recognized. Extensive electrical tests will also have to be made on a complete assembly of repeaters with artificial lines simulating sections of cable. These steps have yet to be taken.

A SUBMARINE cable requires a degree of care and precaution in engineering such as is required in few other situations. It is usually not possible to provide large factors of safety, and yet failure of a single part, such as a break in the conductor or a leak in the insulation, completely destroys the operation of the whole system. Experiences of over eighty years since the failure of the first attempt at an Atlantic cable have led to the development of practices which give good assurance of the reliability of cables of simple construction, but when a device such as the proposed repeater is made a part of the structure a new set of hazards is introduced. Whether these hazards can be guarded against

well enough to justify the risks of such a cable project remains to be seen, but I am optimistic that by a sufficiently thorough job of cable manufacture and a well planned program of trials, the hazards can be reduced to an acceptable degree. It will take some years to reach this point, and at best it must be expected that some degree of hazard will still remain. Submarine cables, like all things that go to sea, can never be completely dissociated from some chance of disaster.

Estimating the Cost

As to the costs of such a cable project for establishment of broad-band wire telephony to England via Newfoundland, only the roughest sort of estimates can be made at this time. However, even applying annual charges somewhat higher than have commonly been used for cables, it appears that the total cost per telephone circuit for the system of two cables with associated equipment will be comparable with that of prospective short-wave radio systems. A considerable increment of cost of cable over that of radio would be justified by the better quality of transmitted speech and the very significant advantage of privacy. Added to this is the value of the cable as a supplement to radio systems to provide against their failure. Indeed, it is possible that, once the cable were in service, radio would be looked on as a supplement to it.

The comparison of cable and radio telephony is not easy to make. It is the composite of cable and radio that assures continuity of service, since, while radio is sensitive to disturbances accompanying magnetic storms, and cable less so, radio service is not so exposed to the possibility of interruption by mechanical accident or malicious intent. An advantage of radio systems is their flexibility, whereby new routes can be established or old routes abandoned without incurring excessive costs. Further, provision can be made for expansion of radio facilities as required without having to install so large a complement of circuits at the outset. The prospect of the combined radio and cable system is a happy one in that it affords the advantage of both types of facility.

In the foregoing discussion I have treated the tranoceanic telephone problem principally as the transatlantic problem and more particularly as the problem of connecting North America and Great Britain. Community of language and many interests lend particular emphasis to that connection, but it is, after all, only one of the many transoceanic links required to build the world-wide telephone network of the future.

When we come to look at other situations, the relative advantages of radio and cable weigh differently. Short-wave radio links have a great advantage in affording direct connection between points on the globe far apart, and the tendency has been to establish short-wave connections directly between large centers rather than through extensive land-line links, particularly where political boundaries have been involved. There has thus grown up an extensive network of single-channel short-wave radio connections operated at low power, giving good service part of the time but not to be depended on all of the time.

Most of these connections are over routes which would not support broad-band systems such as I have discussed. The introduction of broad-band methods for transoceanic radio telephony will tend to favor centralizing radio traffic at a smaller number of more important radio terminals, but it is hardly to be expected that all transoceanic radio traffic will thus be concentrated. Even with radio systems dispersed rather than centralized, broad-band cable may still serve as an effective supplement to radio not only between North America and Great Britain but also between North America and all of Europe, with land lines extending the circuits to all important centers of the European continent. It is to be expected, too, that the cable will find important application in other locations than across the north Atlantic. Notably, this type of cable is particularly promising for trans-Mediterranean service. Indeed, the same principles of construction which are proposed for the transatlantic cable may be applied over much shorter distances. With some modification of design, the repeater can be incorporated in lead-covered cables for shallow seas and afford transmission advantages of carrier as well as the economy of broad-band.

The Network of the Future

IF one tries to imagine the world-wide transoceanic network of the future, he may well envisage a net comprising a large number of light linkages plus a small number of heavy linkages over the most important routes. The light linkages will represent direct short-wave single-channel or twin-channel connections using relatively small power. The heavy linkages will comprise highly developed powerful broad-band short-wave radio systems making full use of frequency and directional diversity supplemented by broad-band submarine cables and in a few cases by long-wave radio as well.

From purely physical considerations, it appears feasible to provide all of the facilities for telephone connection between all points on the earth that its inhabitants are likely soon to require. To what extent these facilities will actually be developed will depend on demand and that, to a considerable extent, on cost. It will be interesting to survey briefly this question of prospective demand to see whether, after all, it promises to be great enough to justify the installation of broad-band cable and radio systems such as are here proposed.

THERE are so many factors that contribute to telephone demand that it is impossible to make any very reliable estimate. In addition to cost, there are factors of differences in time, in language, and in telephone habits, and also the factors of community of interest and speed of service. Similar factors affect the demand for telegraph service, but the transatlantic telegraph habit has had more time to mature fully and may reflect more accurately than the telephone the demand that exists for rapid communication between Europe and America.

One possible way to estimate what the future may have in store for transatlantic telephony is to compare the flow of telegraph traffic, say between London and New York, with that be-

tween New York and some west-coast American city, and then to examine how intensively telephone service has been developed relative to telegraphy over the two routes. Because of its comparative stability over a period of years, New York-San Francisco traffic provides an interesting basis of comparison. The distance and difference in standard time between these two cities compare fairly well with those between New York and London. Difference in community of interest is compensated to some degree by the difference in size of London and San Francisco.

Bases of Comparison

THIS comparison may be made on two bases not very different in character, but leading to widely different results. In the first, let us compare the two routes as regards telegraph traffic, using as our measure the total number of words transmitted in a single year. In the second, let us use as our measure the number of public service telegraph messages, excluding such telegraph business as is comprised under the headings of press service, leased-wire service, and code and cipher messages. In each case the estimate is based on terminating messages and excludes traffic routed via the cities named. Data for the year 1937 are available and this particular year has some further advantage in that it represents something between the peak of the 1929 era and the trough of the succeeding depression.

On the first basis of comparison we find that the total number of telegraph words transmitted between New York and San Francisco in 1937 was approximately the same as that between New York and London. On the second basis we find that the number of telegraph messages was about seven times as great between New York and London as between New York and San Francisco. The wide discrepancy between the two comparisons is doubtless accounted for partly by rates and partly by the character of business and social intercourse. Of the two the second, which is based on plain-word public-service messages, would seem to be more significant in relation to potential demand for telephone service. The information transmitted in press and coded telegraph messages and over leased wires is presumably business of record. Public message telegraphy, as a somewhat closer approximation to the informal exchange of ideas by telephone, may be a better index of telephone demand.

On the basis of these figures we may speculate that the potential demand for telephone connection between New York and London is somewhere between one and seven times that between New York and San Francisco. Actually, in the year 1937 the telephone traffic between New York and San Francisco was about three times that between New York and London. Thus it would appear that not more than a third, and possibly not more than a twentieth, of the potential telephone demand has been realized.

IF we assume, as seems reasonable, that the same ratio of potential to realized demand exists for all European-North American connections as for the New York-London connection, we may estimate that in place of the five pre-war telephone circuits across

the North Atlantic there will be needed from fifteen to one hundred circuits. Which of these figures proves to be the better measure will doubtless depend greatly on costs that can be achieved but I do not think that I can fairly be accused of excessive optimism in predicting a demand for forty or more telephone circuits in the reasonably near future if full advantage is taken of technical possibilities already in view to decrease costs and improve reliability of service.

The Future Demand for Trans-Oceanic Telephone Service

IN estimating the demand for growth it may be a mistake to attach too much importance to cost of service. Speed and reliability are, within limits, just as important. When it becomes possible to pick up a telephone and get a reply within two minutes, which is about the normal time for a long distance connection in the United States, and when the connection provides the clarity and freedom from noise of a local telephone call, then the transoceanic telephone service will, I believe, be used to a degree not even approached at present.

To provide this indicated increase in number of circuits, and to approach land-line standards of reliability and quality of service, will demand utilization of all three types of transmission systems: short-wave, long-wave and repeatered cable. Considerations of cost, flexibility and directness of connection suggest that the bulk of the transatlantic business will be handled on the short waves, but any service important enough to justify so large a group of circuits as has been estimated would have to live up to a higher standard of reliability than short-wave circuits alone can provide. A cable between America and Britain would provide this reliability, acting as insurance against serious interruptions of service that would result from a simultaneous failure of all the short-wave facilities during periods of magnetic storm. It would in addition set a high standard of transmission performance in competition with short waves. The cable and short-wave circuit groups plus a fw long-wave circuits should provide a high degree of reliability and excellent transmission at a level of cost such as would assure the continued growth of the service.

It may not be necessary to wait until the growth of transatlantic telephone business provides enough traffic to utilize fully a cable of the type described. When once the engineers are ready to give reasonable assurance of the cable, I believe that it will not have to await complete economic justification, because of the tremendous importance which it would have in insuring privacy and continuity of transatlantic telephone service. What the cable really waits on is technical development. To achieve this is fairly straightforward, since there do not appear to be any insurmountable difficulties. There is still much to be done, and many difficulties must be overcome before the broad-band repeatered cable can be installed; but it does not impress me as a more difficult problem than many that have been solved in the past.

IN developing this picture of transoceanic telephony I have endeavored to stay within the realm of engineering fact, and not to count on products

yet to be born from the inventor's fancy. Indeed, I may have been overconservative, for there are already partly developed inventions which might greatly modify the picture. One such is the vocoder, an instrument which, in a sense, compresses speech into a narrow band. More accurately, it dissects speech, transmits it in code, and recreates it at the other end of the line. With vocoders a hundred or more simultaneous conversations might be carried by a pair of repeatered cables. While the vocoder would transmit the primary elements of conversation, it would not provide all of those qualities of speech which words alone do not convey. The vocoder gains in band width at the cost of naturalness of speech, but even so, it may find important application.

Other inventions may extend the band width available for transoceanic communication far beyond the range here discussed. Projects such as repeatered ultra-short wave radio systems and undersea wave-guides, which today appear fantastic, may some day come within the range of practicability.

THE electrical channels over which peoples of one continent hold their more urgent communication with those of another have always been of surpassing technical interest. Ever since the first electrical impulses to carry words across the ocean were traced in the wavering beam of Kelvin's mirror galvanometer, the improvement of these channels has been a fruitful field for scientist and inventor. But these paths for the transmission of intelligence have a wider significance than mere technical achievement. They are strands of an ever-growing bond that unites widely separated continents. The newest of these strands, the overseas telephone, has yet to reach its maturity. Not until conversations can be carried on as easily and reliably between continents as between cities within a continent, can we claim that the art of transoceanic telephony has come of age. When this time arrives, we shall probably realize as we look back that the half-dozen telephone circuits of the 1930's formed indeed a slender thread to bind together in speech the people of North America and those of Europe. Some tens of kilocycles of band width may then appear as inadequate as the slowly dispatched words over the first transatlantic cable appear to us today.

"WHAT NUMBER ARE YOU CALLING, PLEASE?"

The Bell System's Intercepting Operators Ask That Question Six Hundred Million Times a Year to Straighten Out Calls That Have Gone Astray for a Variety of Reasons

By LINNÉA H. BAUHAN and GEORGE L. GOUDY

When people talk about telephone usage to friends in the telephone business, sooner or later comes the query, "Why is it that sometimes when I'm waiting for my party to answer, the operator comes in and asks 'What number are you calling, please?' Either I've already given her the number, so she should know it, or I've dialed it—and how can she get in on the connection then?"

The interruption is annoying to the customer who is making the call, to be sure; but not so annoying as the situation would be if the "intercepting operator" did not step in to straighten out a call which has, for some one of a number of reasons, gone astray. If, when he hears "What number are you calling, please?", the customer remembers the number he called, the operator will tell him what detour to take in order to reach the desired telephone; or, she may inform him that he is in a dead-end street, and can go no farther.

The telephone company is as anxious as is the user of its service to have each call go through smoothly, not only because it is always striving to make the service better, but because more work and more expense are entailed in handling a call that is delayed than one which goes through smoothly with no unexpected occurrence. Every effort is made to prevent situations where this phrase must be used, because it has long been recognized as one of the most annoying occurrences that occasionally mar telephone service, although perhaps not so serious as wrong numbers or cutoffs. Consequently, when the telephone user encounters this "What number are you calling, please?" it is because something has happened so that an operator must be called in to redirect the call. She has no previous knowledge of the number called and must, therefore, first ask for the number in order to determine what directions to give.

Actually, about one call in every fifty has to be stopped for this examination, and about half of these occur because the called number is no longer in service. In the aggregate, however, operators give this assistance—"What number are you call-

ing, please?"—over six hundred million times a year on the thirty-five billion calls that are made, so it represents a very appreciable job in the handling of calls.

In a town or small city with manual telephone service, where practically all of the numbers called are within reach of the operator who takes the order, the question rarely occurs. In such a case, the operator has complete control of the call and can set it straight if need be, since she has all the information necessary to give reports herself. The same sort of situation applies, in general, when an operator receives an order for completion to a number in a very small dial office. Most operating, however, cannot be done under such simple conditions, and as the area of local telephone calling is extended, the whole system required to give adequate service becomes increasingly intricate and the problems of giving satisfactory service multiply: the call must be transported over a trunk between offices within the city; the order must be relayed to an operator in the called office who establishes connection; the existence of several central offices increases the possibility of reaching a wrong number; records regarding subscribers' lines cannot be accessible to all operators; operators cannot maintain the same degree of familiarity with thousands of subscribers' lines that they can when only a few hundred are involved, and so on.

These factors, despite efforts to the contrary, tend to produce many kinds of irregular occurrences, including those which give rise to the question, "What number are you calling, please?"

Why the Question?

Why do calls encounter this "Stop" signal? Some causes were implied in an earlier paragraph, but a glance at some of the by-paths into which a call may wander and which require this arresting "What number are you calling, please?" may be of interest.

Figure 1 shows in sketch form the risks that beset a call as it goes from the calling telephone through operators' positions or dial switches over a network of paths and intersections toward its destination—although it must be remembered that this alarming assembly of deterrents only succeeds in affecting about two calls in every hundred. Mistakes by operators and customers and failures of the equipment to function properly all together affect only about one call in a hundred, while some condition at the called telephone or number accounts for another one per cent, on the average.

When a subscriber moves to a new location, conditions in many cases require that his number be changed. This change is usually necessary because all the numbers having a particular central office name, or one of several in an associated group, are served from a given wire center. Obviously, if every subscriber who moved from East to South or North or Lindhurst retained his East number, his line would have to be run all the way across the city from his new location back to the East office. This would soon displace the efficient trunk groups, connecting the various wire centers, with a maze of subscriber lines running all over the area. In other cases, when a subscriber wishes to change his service, from a party

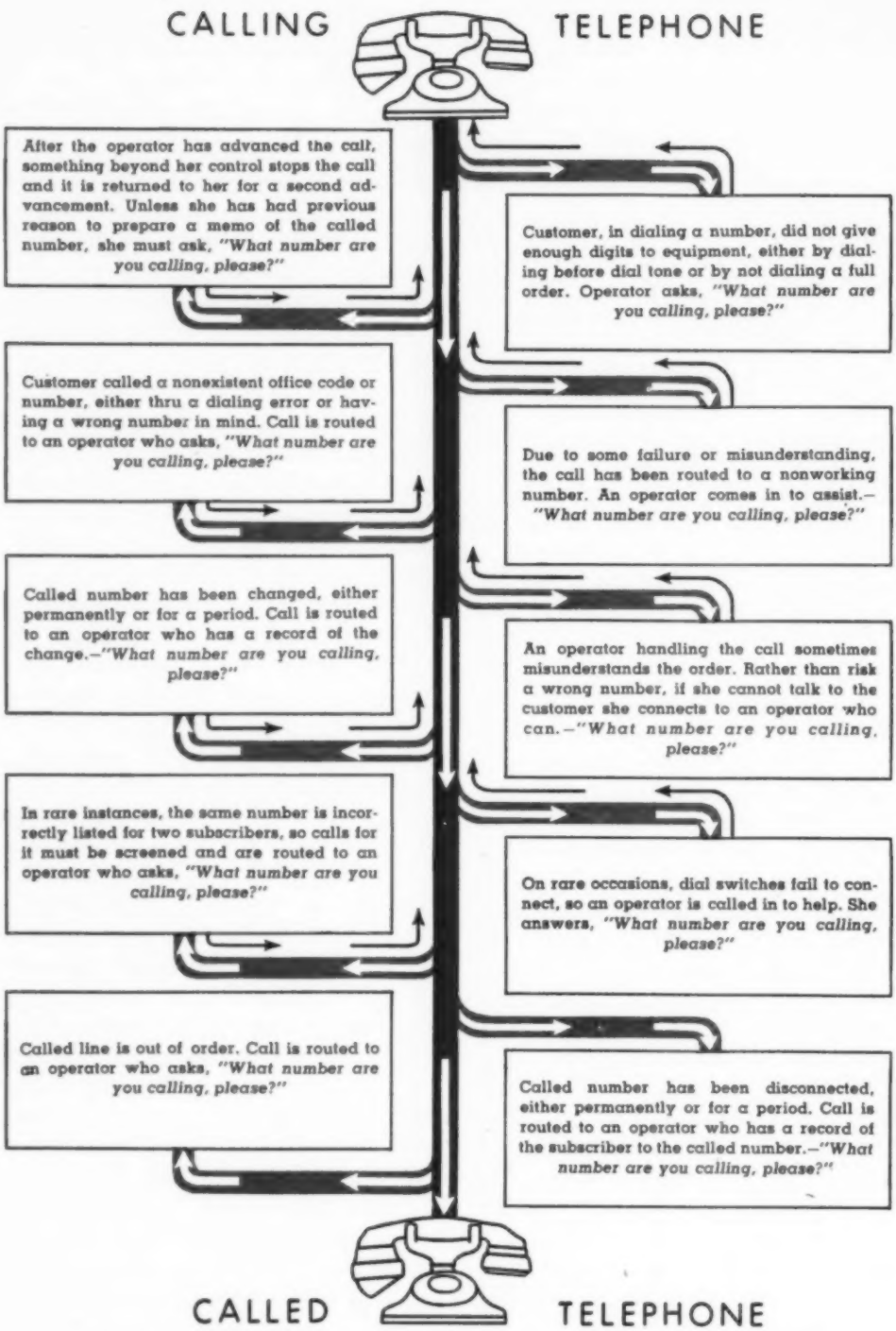

CALLING
TELEPHONE
After the operator has advanced the call, something beyond her control stops the call and it is returned to her for a second advancement. Unless she has had previous reason to prepare a memo of the called number, she must ask, "What number are you calling, please?"
Customer, in dialing a number, did not give enough digits to equipment, either by dialing before dial tone or by not dialing a full order. Operator asks, "What number are you calling, please?"
Customer called a nonexistent office code or number, either thru a dialing error or having a wrong number in mind. Call is routed to an operator who asks, "What number are you calling, please?"
Due to some failure or misunderstanding, the call has been routed to a nonworking number. An operator comes in to assist.—"What number are you calling, please?"
Called number has been changed, either permanently or for a period. Call is routed to an operator who has a record of the change.—"What number are you calling, please?"
An operator handling the call sometimes misunderstands the order. Rather than risk a wrong number, if she cannot talk to the customer she connects to an operator who can.—"What number are you calling, please?"
In rare instances, the same number is incorrectly listed for two subscribers, so calls for it must be screened and are routed to an operator who asks, "What number are you calling, please?"
On rare occasions, dial switches fail to connect, so an operator is called in to help. She answers, "What number are you calling, please?"
Called line is out of order. Call is routed to an operator who asks, "What number are you calling, please?"
Called number has been disconnected, either permanently or for a period. Call is routed to an operator who has a record of the subscriber to the called number.—"What number are you calling, please?"
CALLED
TELEPHONE

FIG. 1. DETOURS AND BLIND ALLEYS ON THE HIGHWAYS OF SPEECH

Calls which encounter these situations require the assistance of an intercepting operator to put them back on the right road to their destinations

line to an individual line for example, it is necessary to move him from his old line, where other parties are still in service, to another line. In some cases, particularly in certain manual offices, this necessitates a change in the subscriber's telephone number, so that calls for his telephone on the former line must be intercepted.

Similarly, a subscriber moving out of town has his service disconnected, and provision is made for reporting where he may be reached by telephone if he has so informed the telephone company. There are also occasions for disconnecting a number temporarily, as when a subscriber is away on an extended trip or is closing his establishment for the season; and there are cases of temporary transfer of incoming calls which a subscriber may request when illness makes the ringing of a bell undesirable or when he finds it necessary to establish himself at a different location for a short period. Again, when a line is known to be out of order, it seems to be better to route calls for it to an operator who can report this fact than to let the calling party try again and again to no avail.

Situations such as those described above cannot, of course, appear in the existing directory, so provision must be made for informing people who call the numbers affected. In all these instances, calls must be intercepted. They must be redirected if possible, or the calling party must be told that the called telephone can no longer be reached—and, because the operator who has access to the records cannot know what number is being called, she must ask, "What number are you calling, please?"

Sometimes something happens in the progress of the call which leads to this question, and then, when the customer gives the number, the operator says, "Will you make your call again, please?" Reference again to Figure 1 discloses a number of occurrences which make it necessary to stop these calls and to put them back on the right road. They all add up to the simple fact that something went wrong on that call.

In spite of the old adage about the customer always being right, sometimes he calls a nonexistent number: for example, his finger slips in dialing and he gives the equipment an order for "9950" (as it happens, a nonworking number) instead of "9050." Sometimes he does not listen for dial tone before starting to dial, so that the equipment understands the order as being for a nonexistent office, "JX" (59), although he is certain that he dialed "OX" (69),—which, of course, is equivalent to removing the receiver from a nondial telephone and immediately speaking the number before the operator answers.

Then, too, occasionally an operator makes a mistake or misunderstands an order and the call goes astray, sometimes to a wrong number, sometimes to meet that irritating "What number are you calling, please?" and its sequel, "Will you make your call again, please?"—since there is nothing the matter with the number the customer called. Sometimes, too, in rare instances, the central office equipment that guides millions of calls unerringly through an amazing labyrinth of paths falters or makes a mistake, and rather than let the customer wait until he

gives up in despair, the equipment tries to make amends by guiding the affected call to an operator who suggests that it be tried again.

Intercepted Calls

THE sketch in Figure 2 illustrates the path of a call to a number which, for example, has been changed. There is no practical means of distributing information on all number changes and disconnected numbers to all the operators in all the central offices of a city, so calls for such numbers must be permitted to go through to the called office, where they are switched to an operator who is provided with suitable up-to-the-minute records for that office.

In a dial office, each telephone affected is connected to a so-called intercepting trunk which terminates before an intercepting operator, or the terminal of the called number is so wired that the equipment testing it is caused to route the call to an intercepting trunk. Thus, as shown in the sketch, incoming calls for a number affected by a change actually go to the terminal for that number in the called central office and then are "turned back" by the intercepting operator instead of being routed from that particular terminal out over the line to the called station.

This would seem to suggest that each intercepting trunk could be designated with the number that has been connected to it, so that the operator would not have to ask for the number when she answers. Some calls received on a particular trunk, however, are for numbers other than the one being intercepted, so that the telephone company is unwilling to have the operator merely report "The number you are calling has been changed to Cedar 7890," for example, without first definitely ascertaining that the call is for the number which has been changed to Cedar 7890. Such a plan would also require many times the number of intercepting trunks now used, since, because the volume of calls to a particular intercepted number is on the average very low, several lines are generally grouped on one intercepting trunk. This is a case where, in the interest of economy, it has seemed advisable to be satisfied with something a little short of perfection.

In a manual central office, an operation roughly similar to that shown on the sketch occurs when a call to a number must be intercepted. Here, again, the call must be taken to the called office, where the operator who tries to establish connection to the called number finds it marked to indicate that calls for it should be intercepted. Instead of completing the call to the line, she transfers it to the intercepting operator, who has a record from which she can report the status of the called telephone.

IDEALLY, all such intercepted calls should be completed to the desired destination without requiring the customer to make his call again, but in many instances this is not practical or economical. Equipment has been developed to make this possible in certain situations, and where it is feasible to do so, the intercepting operator completes the call. That is when she says, "One moment, please," after the customer has told her the number which he called.

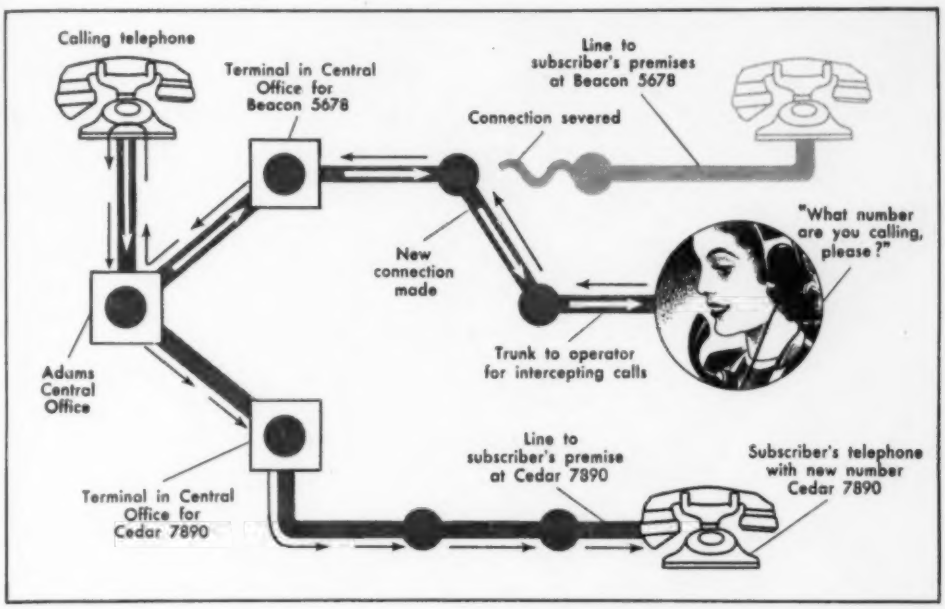

Calling telephone
Terminal in Central Office for Beacon 5678
Line to subscriber's premises at Beacon 5678
Connection severed
"What number are you calling, please?"
New connection made
Trunk to operator for intercepting calls
Adams Central Office
Line to subscriber's premise at Cedar 7890
Subscriber's telephone with new number Cedar 7890
Terminal in Central Office for Cedar 7890

FIG. 2. "THAT NUMBER HAS BEEN CHANGED TO . . ."

In this simplified diagram, Beacon 5678 has been changed to Cedar 7890. A call from a subscriber in the Adams central office to the old number is routed through the Beacon central office (white arrows) to an intercepting operator, who has a record of the change and of the new number—which the subscriber may reach by making another call

One difficulty preventing extension of this practice is the physical limitation of speech transmission. In a multi-office city, the various offices are interconnected by a series of trunk groups in which each pair of wires is "balanced" by added electrical gadgets to carry speech satisfactorily between the two centers it connects. Whenever any two of these trunks are connected together, however, this balance may be disturbed, with resultant impaired transmission—unless the trunks have been designed for such a connection. The wizards of electricity could, of course, design universal trunk circuits that would permit satisfactory speech over any combination of trunks—but the cost would be prohibitive.

A still greater limitation on the extent to which intercepted calls can be completed without asking the user to make his call again is the rate structure as it applies to calls to different points. As already pointed out, when a call reaches the called central office and must be intercepted, it is routed over a trunk to the operator who answers such calls. She has no way of telling whether the call originated in a near-by community and bears a toll charge or whether it came from a customer in her own office; and if she established connection to the desired telephone, the call would be charged in the calling office in accordance with the rate applying from that point to the central office where it was connected to an intercepting trunk.

FIG. 3. AN INTERCEPTING OPERATOR
The records before her enable her to give a report to a customer in an average of twenty seconds

This might result in overcharging or undercharging on a particular call. For example, suppose a person called his next-door neighbor and, through some inadvertence, the call reached an intercepting operator in a distant community, who obligingly completed it back to the neighbor. The equipment or the original operator would charge the call at the rate applying on calls to that town, not knowing that it had been redirected. The intercepting operator performs an unpleasant duty, therefore, in saying, "Will you make your call again, please?" when this danger of an incorrect charge exists on intercepted calls.

Intercepting Positions and Records

MENTION was made earlier in this article of the millions of calls that are interrupted by the question "What

number are you calling, please?"—although they represent only a small percentage of all the calls that are made. Then it developed that calls for intercepted numbers must be routed to a place where suitable records for the called office are available. The operators who answer these calls are generally seated at switchboard positions of which the one shown in Figure 3 is an example, or they are occasionally placed at low-topped desks on which the intercepting trunks terminate.

These positions are the point of origin of the question which the average telephone user may hear possibly once or twice a month but which these operators use thousands of times a day in the Bell System. Sometimes intercepting trunks from central offices in different parts of a city are brought

FIG. 4. AN INTERCEPTING OPERATOR

The larger record book provides space for party-line letters. In a small central office, such an operator handles regular calls as well as those which must be intercepted

together at a central point, so that one group of operators may handle calls for as many as a dozen different central offices. Generally, however, only those central offices located in one building are centralized in this manner, so that the operators at that point need have records for not more than five or six central office units—and when one thinks that a unit represents a possible 10,000 numbers, that seems quite enough.

THE record the intercepting operator uses—the book on the keyshelf before her in Figure 3—is a splendid example of compactness. It must be small enough not to interfere with her other work by obstructing cords, keys, and signals, and not to be unwieldy on the frequent references to it each day. It must be, by all means, a ready reference type, because the customer must be given a prompt report. The average interval from answer to end of report is about twenty seconds, including the intercepting operator's question, the statement of the called number, her search among the thousands of numbers listed, and the report, which frequently involves discussion. And above all, the record must be accurate and complete.

The book in Figure 3 is one form of record, although there are other forms to fit adequately the different types of positions, to provide for the party line station letters commonly found in manual offices, etc. This particular book shows the working status of the numbers in three central office units—about 30,000 numbers.

A different form of record is shown in Figure 4, where it is in use by an operator who, while specializing in intercepted calls, is located in an office small enough so that her full time is not required for them. She therefore handles calls from regular subscriber lines when she is not engaged on calls for these intercepted numbers. The larger book is necessary to provide spaces for showing the status of each of the J, M, R, and W parties on a line—a requirement not present in a dial office, where every subscriber has a separate number.

Figure 5 might be called a candid camera picture of the intercepting record shown in Figure 3. There are, again, variations to fit different types of offices, but this one will suffice to illustrate how compactly the necessary information is entered.

EACH page of this record has spaces for the block of one hundred consecutive numbers designated in the page heading so that, with the proper series of pages, space is available for an entry affecting any number in the office. Liberal use of codes is made to conserve space. Thus, in the illustration which shows the 1100 block in the West office, the number written next to "34" represents the number to which West 1134 has been changed, and the "V" next to "78" indicates that West 1178 is vacant or not working. Reference codes guide the operator to the larger spaces in certain instances where the small block is not large enough to contain the required entry. These more complicated entries frequently lead to more questioning, which may be considered annoying; but it has been found that on about ten to twenty per cent of the calls for disconnected numbers the customer is not calling the subscriber

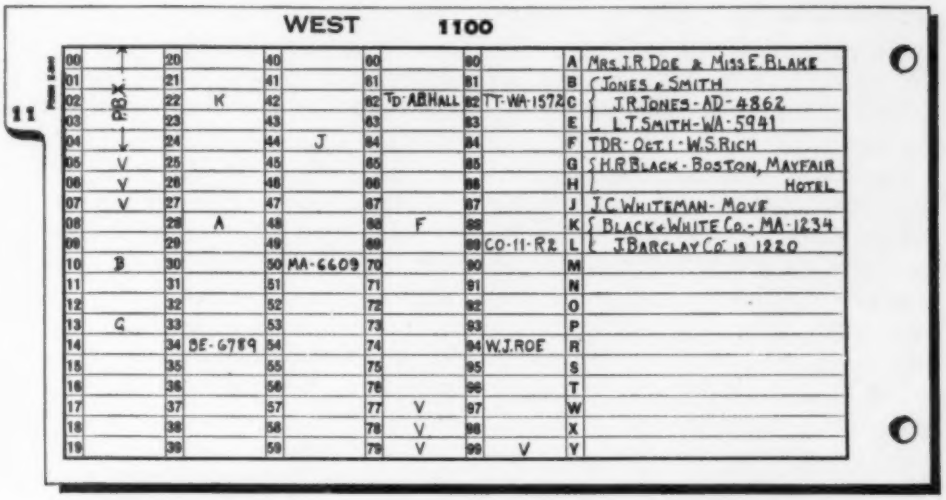


FIG. 5. A PAGE FROM AN INTERCEPTING RECORD

The space-saving codes have definite meaning to the operators who use the books as their working tools

listed for that number. So, since a disconnect report has such an air of finality, it is general practice, as a safeguard, to ask the name of the called party or to tell the customer the name of the subscriber for whom the number is listed.

Sometimes reference notes become quite involved. For example, when the law firm of Jones, Jones, Jones, and Jones dissolves and each partner sets up a separate office, the intercepting operator must question all calls for the old number, so that she may give the correct telephone number of the particular Jones the customer wishes to reach. This seems a burdensome practice, but it is necessary in order to maintain impartial service to all members of the dissolved firm.

LIKE the supply service of a modern army is the organization which keeps these intercepting records posted almost literally up to the minute and provides for routing calls to the intercepting positions. When, for instance, a subscriber tells the telephone business office that he wishes the service in his summer bungalow discontinued for the winter, several copies of a service order are prepared by the business office. One copy, sent to the plant department, is its order to do any work that may be required, such as connecting the number to an intercepting trunk as shown in the sketch in Figure 2. Another copy goes to the traffic department, where a clerk in the central office posts the record described above at the time the order is to take effect. In addition, if the office is manual, the clerk also goes along the switchboard and marks each of the several appearances of the line, so that any operator attempting to establish connection to that number will see that she should not do so and will, instead, route the call to the op-

erator who answers with "What number are you calling, please?" and gives the information that Mr. Abernathy's telephone has been disconnected for the season.

On some changes, outside plant work must be done, and the traffic clerk's work on the order must be carefully timed so that calls for the number will not be intercepted too soon. As soon as the test desk-man knows that work has been completed, he calls the traffic clerk, and within a few minutes the changes are put into operation and incoming calls for the old number are being rerouted or calls for the new number are flowing smoothly to the desired station.

Trouble Monitors in Dial Offices

MILLIONS of dialed calls are completed swiftly, silently, accurately by the switching equipment without human aid; but in certain types of dial offices, the moment a unit of completing equipment is delayed in its work or fails to perform its appointed task promptly, a signal brings the situation to the attention of an operator who answers with "What number are you calling, please?" Her position, known as the sender monitor position, is equipped with signal lamps and jacks associated with vital parts of the central office mechanism.

If a customer removes the receiver and waits too long before he dials, she is called in. If he dials before he hears the dial tone, so that the equipment does not receive an adequate number of digits, or if he does not dial the number of digits the equipment has been arranged to receive, she is called in. If the automatic equipment fails to advance the call within a reasonable number of seconds, she is called in. In each case, the distinctive nature of the signal has told her a part of the story as to what has gone wrong on the call, but she must ask for the called number in order to identify the condition completely and to prescribe the best action for that situation.

IF one watched this operator for a while, one might receive the impression that she was careless in her attention to signals. Actually, however, she is especially trained for this work and knows that certain of the busily flashing or steadily lighted signals before her convey a meaning but do not require an answer. Other signals, she knows she has already taken preliminary action on or reported, but they will continue to burn until the difficulty has been cleared. In this way she can know at all times just the extent to which certain important channels in the office are being restricted by equipment being held out of service for examination. She knows also the number of pieces of equipment in each channel which can be safely "busied out" for maintenance testing without affecting service, and when this number is reached, she takes action to have some of the normal "checking up" by the plant forces postponed so that the highways of speech may be kept clear for all to use.

Most troubles that put a line out of service, and all cases where a receiver has been left off the hook for an interval, not only "busy" the line but seize and hold important equipment used in establishing connections. The

equipment routes all such lines to special trunks appearing before this trouble monitor, thereby freeing itself for further use and enabling her to take suitable action. She challenges with "What number are you calling, please?" and if she receives no response she tests the line for trouble. In many cases, by her alertness to the rate at which troubles are appearing, she is able to start corrective action on major cable troubles sooner than would be done otherwise.

Perhaps this monitor's most fascinating function is to sense the approach of an overload on the dial equipment. Certain groups of signals appearing before her indicate, by the frequency and constancy with which they light, when the vital channels are becoming fully loaded by the thousands of calls surging through them. At the same time, the other conditions previously described tell her whether this loaded condition is due only to a large volume of calls moving properly, or to trouble that is partially clogging the main channels, or to customers who have been in too great a hurry to wait for dial tone. Before the situation has developed to acute stages, her skilled appraisal has started corrective action which in most cases relieves the danger of worse congestion. But in all of this, one of her most useful tools must be "What number are you calling, please?" and the request to make the call again.

The Question Itself

"WHAT number are you calling, please?" is not an easy phrase to repeat over and over, especially when it must be said each time so carefully and distinctly that the customer who hears it unexpectedly will understand it. At one time it was thought that the customer needed to be informed that the operator who asked this question was not the one who took his order initially, and so she used the introductory phrase, "This is a special operator," as a prelude to the question. That lengthened the transaction and came to seem unnecessary, so it is now generally omitted and reliance is placed on good tone and manner to convey, not only that this is a different operator from the one to whom the order was given originally, but also that she is interested in the call and would like to be of help.

Then again, the phrase used to be "did you call," instead of "are you calling," but it was very difficult to avoid slurring that into something like "didja call," which certainly did not convey the impression that this operator was trying to be helpful and painstaking. "What number are you calling, please?" is, therefore, merely a present view on the best way to introduce this unexpected interruption on a call that has gone astray and needs some extra attention which the operator will give,—with the necessary assistance of the customer.

Whatever words the operator uses, her meaning is always: "I'm sorry, but something has interfered with the progress of your call and I'd like to help you get on with it—if you'll tell me what number you're calling."

FOR THE RECORD

THE BELL SYSTEM IN WAR-TIME

Statement read by President Walter S. Gifford at the Annual Meeting of A. T. & T. Stockholders on April 15, 1942

OVER 9,500 * Bell System employees are already in the military services. The rest of us in the System are aggressively doing our part to win the war and to protect the liberties we so dearly cherish. We are determined to see to it that those in uniform are backed up on the home front with all the skill and energy and resourcefulness that we have.

I am sure that is what you, the stockholders, want us to do. You have provided the wherewithal with which the telephone lines, the switchboards and buildings have been built. You have invested your savings in a great public service in peace times and a vital part of the nation's defense in war times—vital to fighting the war through to victory.

As you have seen from the statement enclosed with your dividend check that arrived in your home or office this morning, the earnings of the System with present tax rates are more than covering the dividend. This, in spite of the fact that these taxes are nearly $5 a share per year greater than in 1940. You will also have noticed that the tax proposals of the Secretary of the Treasury would reduce earnings by an additional $4 per share per year, so that, if those proposals were enacted into law, the usual dividend would not be earned in full. In fact, the earnings on investment would be reduced to the lowest point on record, including the worst year of the recent depression.

During the depression, you will recall, the Company continued to pay dividends at the usual rate although, because of depressed business conditions, they were not fully earned and were paid in part out of surplus. There are too many uncertainties ahead today to say in advance what it might be wise to do if, due to war-time taxes and not to a depression, earnings again should not fully cover the dividend requirements.

Conditions are obviously not the same as in the depression. Then we had a telephone plant which could handle more business than we had, and it was clear that we would again earn the dividend as soon as we had more business. Now we have all the business that we can handle—with no spare or idle plant, in spite of having added nearly one billion dollars of telephone plant since 1935—and yet because of increased taxes needed for the winning of the war, we may not fully earn the $9 dividend. We are making all possible operating economies, and if and where it becomes necessary, we shall ask regulatory bodies to permit us to increase revenues by increases in telephone rates so far as is not inconsistent with winning the war or with the public interest.

Because of the urgent need of copper and other essential materials for the war effort, construction of new facilities to care for civilian demand for telephone service is being more and more restricted by government priority regulations. This

* Now over 11,000.

will mean great inconvenience and even hardship for increasing numbers of persons. However, whatever the difficulties ahead for the Bell System and for telephone users, they are difficulties growing out of the war.

And how long will the war last? My own answer is, it will last until we win it. I have spent my working life with the Bell System—nearly 38 years. I have seen the System go through many trials and tribulations, but it has always come through stronger than ever. Because telephone service is worth so much more than it costs and because of the high character and ability of Bell System personnel and for other important reasons, as a stockholder myself—and nearly all my personal savings are invested in the business—I look to the future of the Company with full confidence.

For the duration, the Bell System, come what may, can be counted on to do its full part in the war, and by so doing it will be keeping faith with those in the fighting forces and on the fighting fronts who, after all, have the toughest job to do.

"THIS IS YOUR WAR"

A Talk Given by Vice President Arthur W. Page of the A. T. and T. Company before a Meeting of Supervisors of the New England Telephone and Telegraph Company in Boston on March 24, 1942

THE fundamental policies of the Bell System have been:

1. to give the best possible service at the least cost consistent with the financial integrity of the business.
2. to carry on research and development for the development of the telephone art.
3. to protect the investment of the owners of the business for them and for the future use of the public.
4. to pay adequate salaries and wages, and provide the most opportunity possible.

At present there is a fifth part of the policy that overrides them all—

5. to run the Bell System so that it does its maximum service in winning the war.

And we are particularly fortunate in the fact that our business is vital in this national emergency. That does not make so much difference to those who are young enough or smart enough to go into the war directly, but for the rest of us it's a vast comfort to be in an enterprise essential to the nation in these times.

You read every few minutes that the United States is the arsenal of democracy, that our production is the basis of victory. We take it for granted. Let's analyze it a little. In Russia there is as much raw material as and more people than there are here. They have been working on their army and its equipment for many years. Yet everyone expects us to send them machines a couple of years after we start making blue-prints.

Why? Well, it's know-how and organization. That isn't just a number of people, nor just a number of smart or trained individuals. It's well trained teams.

The chief assets of the United States for this emergency are a number of well-trained teams, not the least of which is the Bell System. It's a team of 400,000. The 400,000 can play their positions and they all know the plays and the signals, and what this team does is absolutely vital, for over its wires go the signals of all the other teams that are getting things done.

We can be thankful that we are on the main line. We also have to be careful that we act like people on the main line.

Well, why not? What is to prevent us? I'll tell you. This country has been through a lot of wars and other troubles and it comes out in the long run and for one reason—and it isn't that everybody does his part. Everybody doesn't. It's because the real people who know how and have the character and guts get the things done anyhow.

There will be people who can't do anything, and people with mean and petty motives, blind spots, dishonesty, selfishness, all kinds of human impediments. You'll get rulings you just couldn't believe would happen in war time. You won't have everything you need to do your job. You'll have a lot of other difficulties. You'll have forty troubles about which you could complain all day if you have a mind to.

But you aren't going to do it, for the reason that this is your war.

I don't mean that it's your war in equal parts as it is the whole population's. I mean it's your war in the measure of your competence, and by that I mean it's a whole lot your war. We're going to be the least complaining and the most effective outfit in the United States. That's the over-all policy.

We've got a good place in the line and the job is to win as fast as the Lord will let us. If there are some people you think you just have to do something about—and I have that feeling quite strongly at times—they will just have to wait their turn behind Hitler, the Jap, and Mussolini.

At present and increasingly so in the immediate future we are going to be short of materials. We are not going to be able to give everyone everything he wants. We have had no practise in holding off customers, for nearly twenty years. But I do not expect any real public reaction if we are frank and honest in telling people why they can't have what they want.

And, after all, the material we are going to do without is so very little. To you who have always lived in the Bell System, the idea of losing most or all of the construction program may seem cataclysmic; but it isn't, for we are in a business of selling service and not materials.

When a tire company gets no materials, it has no business at all. When we get no materials, we still have as much business as we ever had before and the capacity to serve the vital needs of the country. What's happened to us is we just can't grow as usual—and as a matter of fact, we wouldn't be growing this way if it weren't for the war, anyhow.

What will happen to us after the war? I am sure I don't know, but I am equally certain that it is nothing to worry about now. If the Bell System is a rigid system and hasn't flexibility and imagination at the top, it may not be able to meet the inevitable changes and take advantage of them. But there is no reason why we shouldn't be flexible and alert.

There is sure to be change. Some people take advantage of change, others don't, but I don't know why we shouldn't make the most of it as well as the next man. People are going to keep talking, and one way or another we ought to be able to make it possible and pleasant for them to do so and profitable to us.

SERVICE OPENED TO DUTCH GUIANA

TELEPHONE communication between the United States and Paramaribo, Dutch Guiana, was opened on May 4. The service is handled over a short-wave radio telephone circuit operated by the American Telephone and Telegraph Company

in New York and by the Netherlands colonial government in Paramaribo. The rate for a three-minute conversation between these two points is $12 on weekdays and $9 on Sunday. The daily operating period is from 8:30 A.M. to 6 P.M.

CONTRIBUTORS TO THIS ISSUE

As our readers doubtless assumed from his thorough-going knowledge of the Civilian Defense organization and its communication requirements, F. SELWYN GAY is the man who was appointed liaison officer between the Bell System and the O.C.D. in June of 1941. The assignment has occupied practically all his time since then, and he has been largely responsible for the training courses and the training material which have enabled representatives throughout the System to act as communication advisers to local civilian defense groups. Since the appointment of a Defense Activities Engineer in the A. T. and T. Company last December, Mr. Gay has been a member of his staff.

Graduated from the U. S. Military Academy with the B.S. degree in 1920, Mr. Gay served as Second Lieutenant and First Lieutenant, C. A. C., until 1923. In that year he joined the New York Telephone Company, where he was successively a manager, district manager, and division sales manager. In 1929 he was transferred to the Commercial Division of the Department of Operation and Engineering of the A. T. and T. Company, where, prior to his present assignment, he had been in recent years a group head in charge of sales results and then of business exchange sales. He is the author of "Proving the Value of Telephone Orders to Department Stores," which was published in the BELL TELEPHONE QUARTERLY for July, 1938.

AFTER graduation from Harvard University with the B.A. degree in 1904, where he completed the four-year course in three years, WALTER S. GIFFORD joined the Bell System as a clerk in the payroll department of the Western Electric Company in Chicago. The following year he was transferred to New York, becoming assistant secretary and assistant treasurer of the company. In 1908 he joined the American Telephone and Telegraph Company, and from 1911 to 1916 was its Chief Statistician. Returning to the company in 1918 from his war-time responsibilities, he was appointed Comptroller. In 1919 he was elected a Vice President; in 1923, Executive Vice President; and in 1925, President.

Early in 1916, at the request of the Naval Consulting Board, Mr. Gifford directed the work of the National Industrial Preparedness Campaign. Late in that year Congress created the Council of National Defense, and from December of 1916 to November of 1918 he was Director of both the Council and its Advisory Commission. In July of 1918 he went to Paris, where he served for four months as Secretary of the American section of the Inter-allied Munitions Council.

At present, Mr. Gifford is Chairman of the Industry Advisory Committee of the Defense Communications Board.

Concerning Mr. Gifford's many charitable, educational, and scientific interests it is perhaps sufficient to cite that in 1938 he received the gold medal of the National Institute of Social Sciences in recognition of his services "as Director of

the Council of National Defense; President of the Charity Organization Society of New York; Trustee of Johns Hopkins University, General Education Board, Carnegie Institution of Washington; Director of the President's Organization on Unemployment Relief; President of the American Telephone and Telegraph Company, the greatest non-governmental organized service in the United States; and as trustee of numerous educational and scientific foundations."

GRADUATED from Purdue University in Mechanical Engineering in 1910, TEMPLE C. SMITH immediately joined the New York Telephone Company, where he started work in plant engineering. After four years in that work, he spent two years laying out electric light plants. Returning to the New York Telephone Company in 1916, he was assigned to various outside plant problems for three years, ranging from motor vehicle equipment development to long-span-crossing design. In the two years which followed, he specialized on motor vehicle operation and maintenance. Since 1921 Mr. Smith's work has been concerned with automotive and construction apparatus engineering in the A. T. and T. Company.

His connections with outside organizations have included: work on A.S.T.M. committees and committees of the American Standards Association; membership on the Highway Research Board of the National Research Council; contributions to the work of the Committee on Winter Driving Hazards of the National Safety Council; participation in the studies of the Committee on Definitions of the National Conference on Uniform Traffic Accident Statistics; and an active part in the work of various committees of the Society of Automotive Engineers, of which he has been Chairman of the Highways Research Committee for many years.

PRESIDENT of the Bell Telephone Laboratories since October, 1940, OLIVER E. BUCKLEY joined its predecessor, the Research Department of the Western Electric Company, as a research physicist in 1914 after having received the Ph.D. degree from Cornell University. He had been graduated with a B.S. from Grinnell College in 1909. His first assignments were to the study of oscillators and the development of vacuum tubes.

During the first World War, Dr. Buckley served as Major, Signal Corps, A.E.F., in charge of the research section of the division of Research and Inspection of the Signal Corps in Paris.

Returning to the Laboratories after the war, Dr. Buckley undertook an investigation of submarine telegraph cables, and soon recognized the possibility of greatly increasing their message capacity by the application of new techniques and new materials. Among the latter were the new nickel-iron alloys, and notably permalloy. A practical solution of the problems of high-speed submarine telegraphy required, however, the solution of numerous subsidiary problems as well as that of the manufacture of a cable with a loading of permalloy tape wrapped around a copper conductor. First result of this development work at the Laboratories was the Western Union's 1924 cable between New York and the Azores, which under engineering tests transmitted 1900 letters a minute, as contrasted with the 500 letters of the corresponding non-loaded cable then in use. Other researches under his direction have led to a better understanding of ferro-magnetism and to the development of better magnetic materials for specific applications; and have also concerned discontinuities in magnetization, and the conduction of current in vacuum tubes and solid conductors.

Dr. Buckley was made Assistant Director of Research in 1927, Director of Research in 1933, and Executive Vice President of the Laboratories in 1937.

He received the honorary degree of Doctor of Science from Grinnell in 1936. He is Chairman of the Board of the Engineering Foundation, a member of the National Academy of Sciences and of the American Philosophical Society, and a fellow of several engineering and scientific societies.

After receiving a B.A. degree from Barnard College, Linnéa H. Bauhan spent two years as statistician to a financial engineer. In 1917 she joined the American Telephone and Telegraph Company in the Traffic Section of the Engineering Department (now the Department of Operation and Engineering) to work on local operators' training department methods and practices. She later became an engineering assistant on local operating methods and practices, and of recent years has worked exclusively on operating practices.

Entering the Bell System by way of the Chesapeake and Potomac Telephone Company from the Engineering Department of the University of Virginia in 1921, George L. Goudy was concerned with dial service inspection in Norfolk and Baltimore and dial traffic engineering in Washington until he was transferred to the Traffic Division of the Department of Operation and Engineering of the A. T. & T. Company in 1924. In this group his attention has been devoted to quantitative and qualitative measurements of traffic operation and, currently, to operating practices.